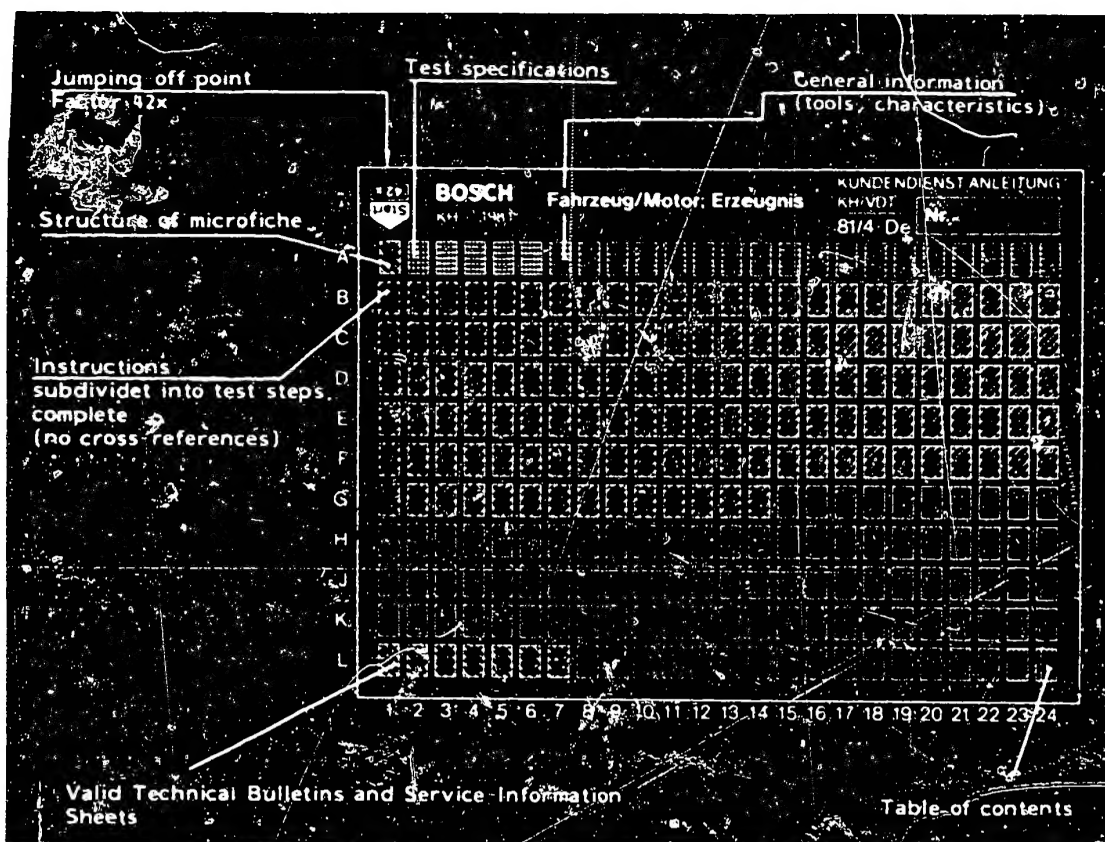


Structure of microfiche

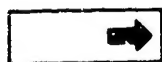


1. Read from left to right
2. Title of microfiche (appears on each coordinate)

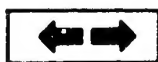
E 16	Product/assembly/test step	
	Vehicle/engine	

Coordinate

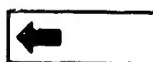
3. Limits of section



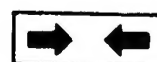
Beginning



Mid-section



End



One-page section

4. References to relevant test steps in test specifications; coordinate e.g. C6

C 6

A 1

Trouble-shooting program



1. Test specifications - electrical

Coil resistances

D5

Solenoid switch	Opposing winding	Pull-in winding	Holding winding
0 331 500	Ω	Ω	Ω
.. 001	0.63	0.16	1.8
.. 002	0.58	0.11	1.8
.. 003	0.27	0.11	1.5
.. 009	0.515	0.11	1.5
.. 011	0.515	0.11	1.5
.. 012	0.27	0.11	1.5
.. 023	0.27	0.11	1.5
.. 024	0.27	0.11	1.5
.. 028	0.515	0.11	1.5
.. 033	0.27	0.11	1.6

Power relay:

Internal resistance of winding approx. 5 ohm.

D11

Brake winding:

Starting motor

0 001 600 .., .. 611 .. = 0.053 ohm $\pm 10\%$

Starting motor

0 001 601 .., .. 608 .. = 0.072 ohm $\pm 10\%$

C23

Minimum voltage for solenoid switch
(mounted on starting motor)

Starting motor

0 001 600	14 V
602 001	14 V
602 002	14 V
603 ...	14 V
0 001 601 ...	12 V
608 ...	12 V
0 001 611 ...	13 V
613 001	13 V

E12

A2

Test specifications - electrical

T-type starting motor 0 001 6 ..., 24 V



Test specifications - electrical (continued)

No-load values	V	A	min ⁻¹
Starting			
motor 0 001 600 ...	22.5	<115	6000
601 ...	22.5	<170	6000
602 001	22.5	<115	4100
602 002	22.5	<115	4800
603 001	22	<170	5800
603 ...	22	<170	4200
608 ...	23	<140	3700
608 001	23	<170	3500
608 002, 003, 005	23	<140	3700
608 004, 006, 007	23	<140	6000
611 ...	23	<130	4000
613 001	23	<210	4900

Short-circuit values	V	A	Md(Nm)
Starting			
motor 0 001 600 ...	8	1400-1570	133
	7	1200-1380	177
601 ...	5	1700-1910	155
	4.5	1510-1730	140
602 001	8	1400-1590	205
	7	1220-1400	180
602 002	8	1400-1590	185
	7	1220-1400	160
603 001	5	1700-1910	145
	4.5	1510-1730	130
603 ...	5	1700-1910	145
	4.5	1510-1730	130
608 ...	5	1700-1920	140
	4.5	1610-1730	126
608 001	5	1700-1910	140
	4.5	1610-1730	126
608 002, 003, 005	5	1680-1880	225
	4.5	1500-1700	200
608 004, 006, 007	5	1700-1900	146
	4.5	1530-1730	130
611 ...	8	1330-1580	195
	7	1200-1400	170
613 001	9	3300	280

A3

Test specifications - electrical

T-type starting motor 0 001 6 ..., 24 V



2. Test specifications - mechanical

Commutator \varnothing new	80 mm	C7
Commutator \varnothing minimum	77 mm	

Brush pressure (per compression spring)	13 - 16 N	E4
for TF starting motor 0 001 613 001	14 - 15 N	
Carbon brush minimum length	17 mm	

Longitudinal play of armature	0.2 - 0.4 mm	D12
-------------------------------	--------------	------------

Longitudinal play of drive spindle	0.5 - 1.3 mm	C16
------------------------------------	--------------	------------

Return spring on armature shaft (engagement shaft)		C22
Starting pressure	70 - 90 N	
End pressure	110 - 130 N	

Multi-disc clutch
Overrunning torque

Starting motor 0 001 600 ...		
601 ...	0.6 - 1.0 Nm	C15
602 ...}		
603 ...		
Starting motor 0 001 608 001	0.8 - 1.8 Nm	
002		
.		
·	0.6 - 1.0 Nm	
·		
·		
008		

Slipping torque

Starting motor 0 001 600 ...		C13
601 ...	300 - 420 Nm	
602 ...}		
603 ...		
Starting motor 0 001 608 ...	320 - 420 Nm	
611 ...}		
Starting motor 0 001 613 011	420 - 500 Nm	

A4

Test specifications - mechanical

T-type starting motor 0 001 6 ..., 24 V



Test specifications - mechanical (continued)

Backlash	0.7 ... 0.9 mm
Pinion clearance	3.0 ... 4.0 mm

Tightening torque for Uni-Stop nut
on starting-motor pinion TB starting
motor 0 001 600 ..., 601 ...,
TE starting motor 0 001 602 ...,
.. 603 ..

35 ... 45 Nm

(3.5 ... 4.5 mkgf)

D23

Tightening torque for bolt with
Loc-wel strip on TF starting
motor 0 001 608 ..., .. 611 ...,
513 ..

40 ... 50 Nm
(4.0 ... 5.0 mkgf)

E2

Tightening torque for micro-
encapsulated bolts of inter-
mediate bearing

7 ... 8 Nm

Tightening torque for round
nut on multi-disc clutch

100 Nm

C10

Commutator true-running error
Armature laminated core true-
running error

max. 0.03 mm

max. 0.1 mm

D12

Setting the power relay:
Armature travel with power relay
completely installed:

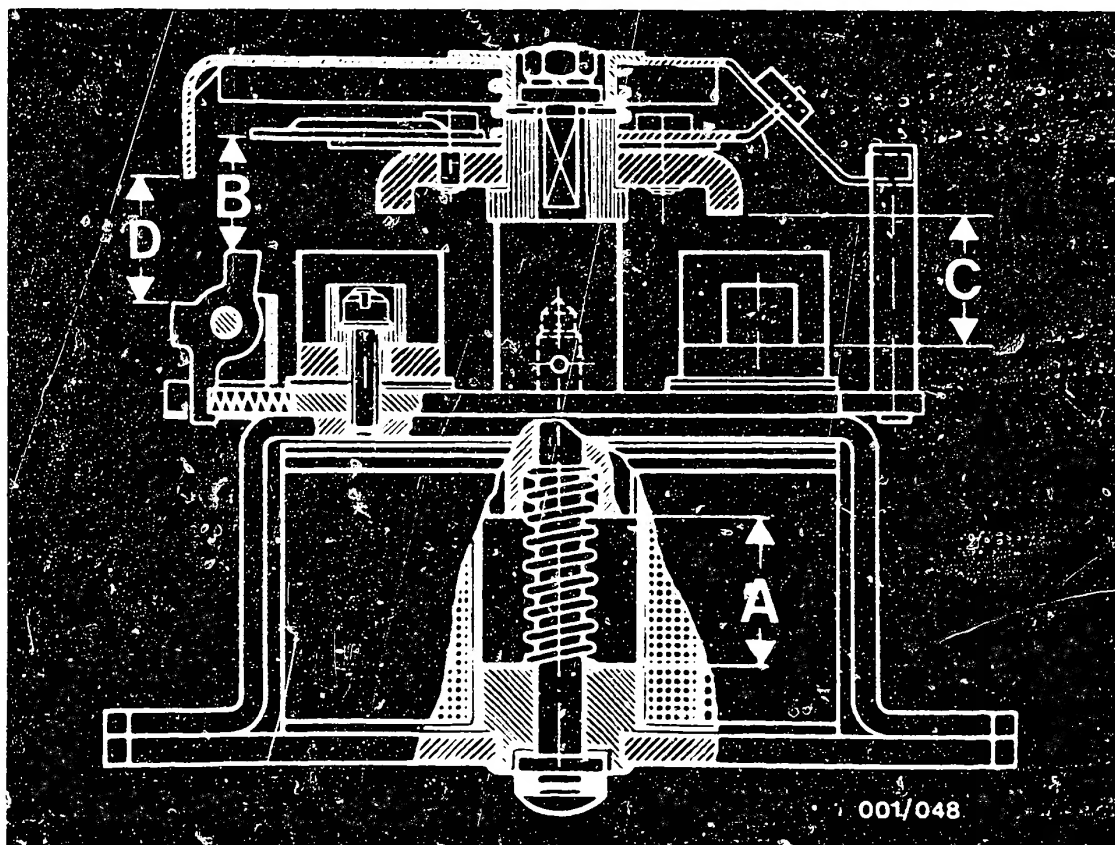
3.3 ± 0.2 mm

A5

Test specifications - mechanical

T-type starting motor 0 001 6 .., 24 V





Adjust solenoid switch

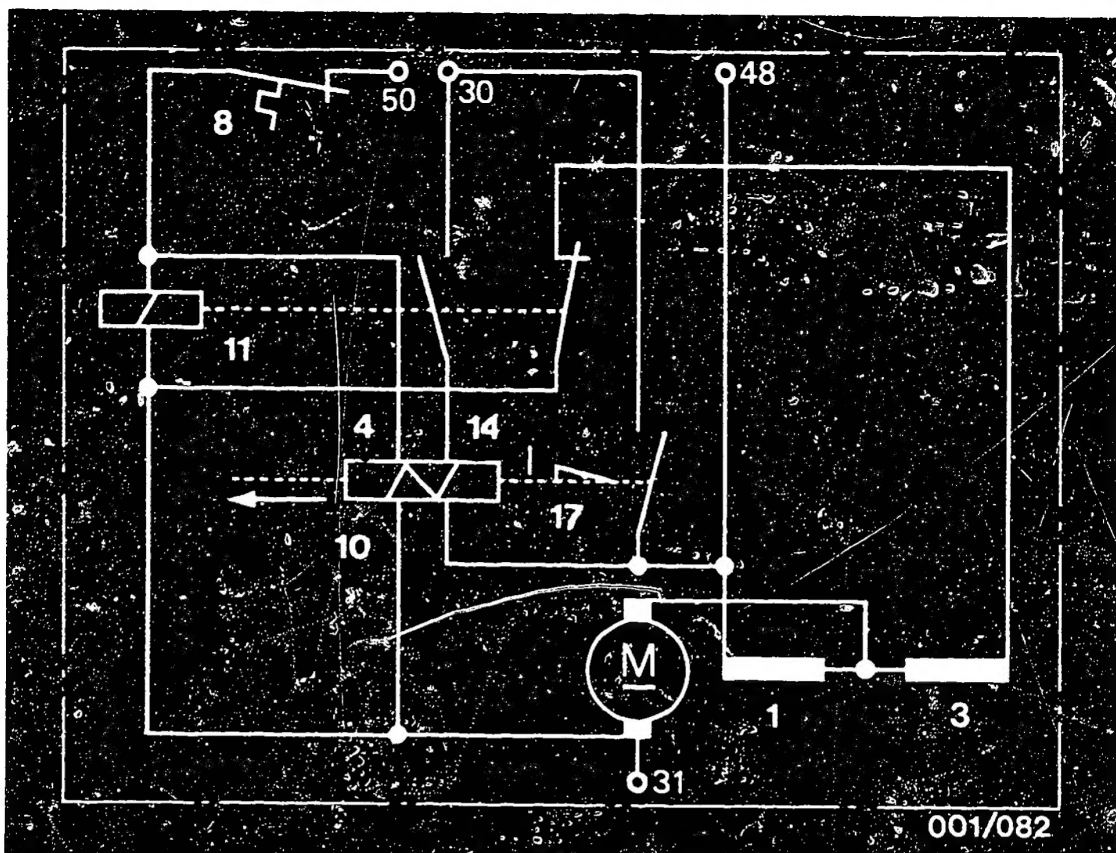
- A = Stroke of magnetic core: 25 ± 0.2 mm.
Adjust by turning the pressure cap (8mm fine-pitch thread). Then drive in straight pin.
- B = Clearance between locking lever and ratchet lever:
 19.8 ± 0.3 mm. Use shims.
- C = Clearance between bus bar and bridging contact member 22.4 ± 0.3 mm.
- D = Clearance between release lever and ratchet lever:
 23.5 ± 0.5 mm. Place shims under release lever.

A6

Test specifications

T-Type starting motors 0 001 6.., 24 V





- | | |
|-------------------|---------------------------------|
| 1 Series winding | 10 Solenoid switch |
| 3 Brake winding | 11 Power relay |
| 4 Holding winding | (control relay) |
| 8 Thermo-switch | 14 Pull-in and opposing winding |
| | 17 Detent pawl |

Circuit diagram for starting motors (single-starting motors)

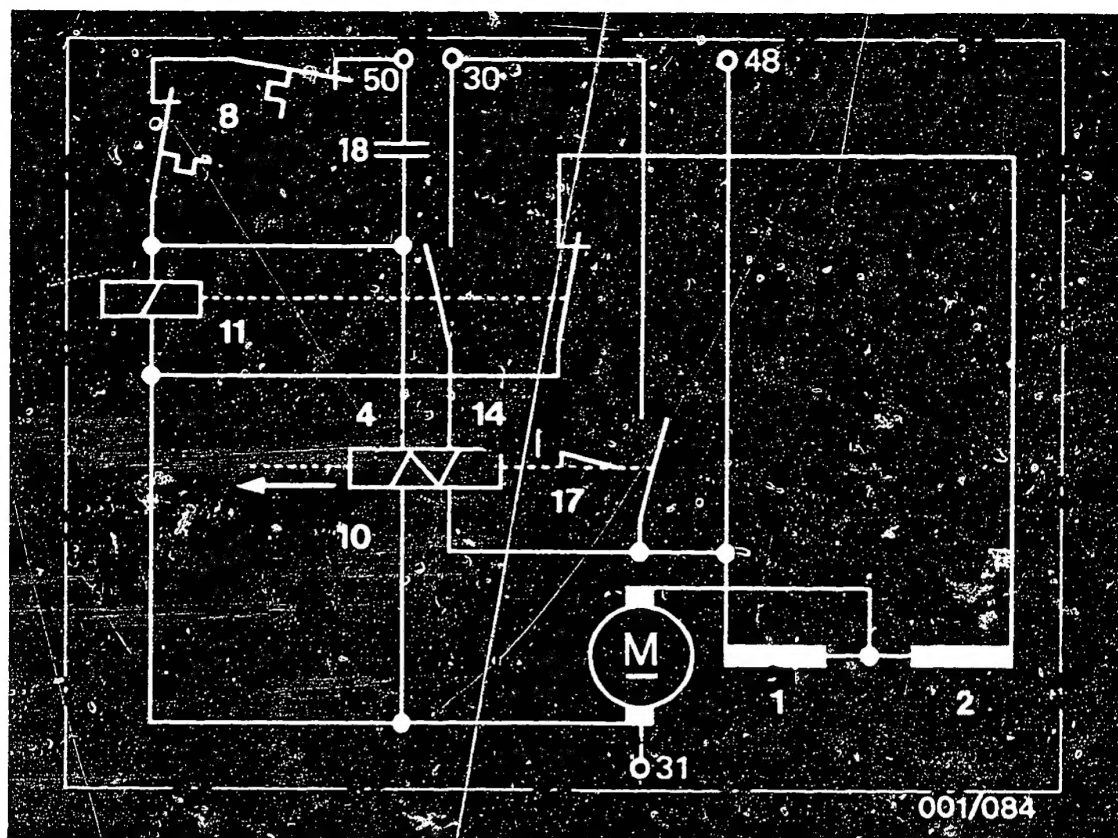
0 001 600 002	Item 8 only in
501 018	0 001 601 018
603 201	
608 003	
.. 004	
.. 005	

A7

Circuit diagrams

T-type starting motor 0 001 6 ..., 24 V



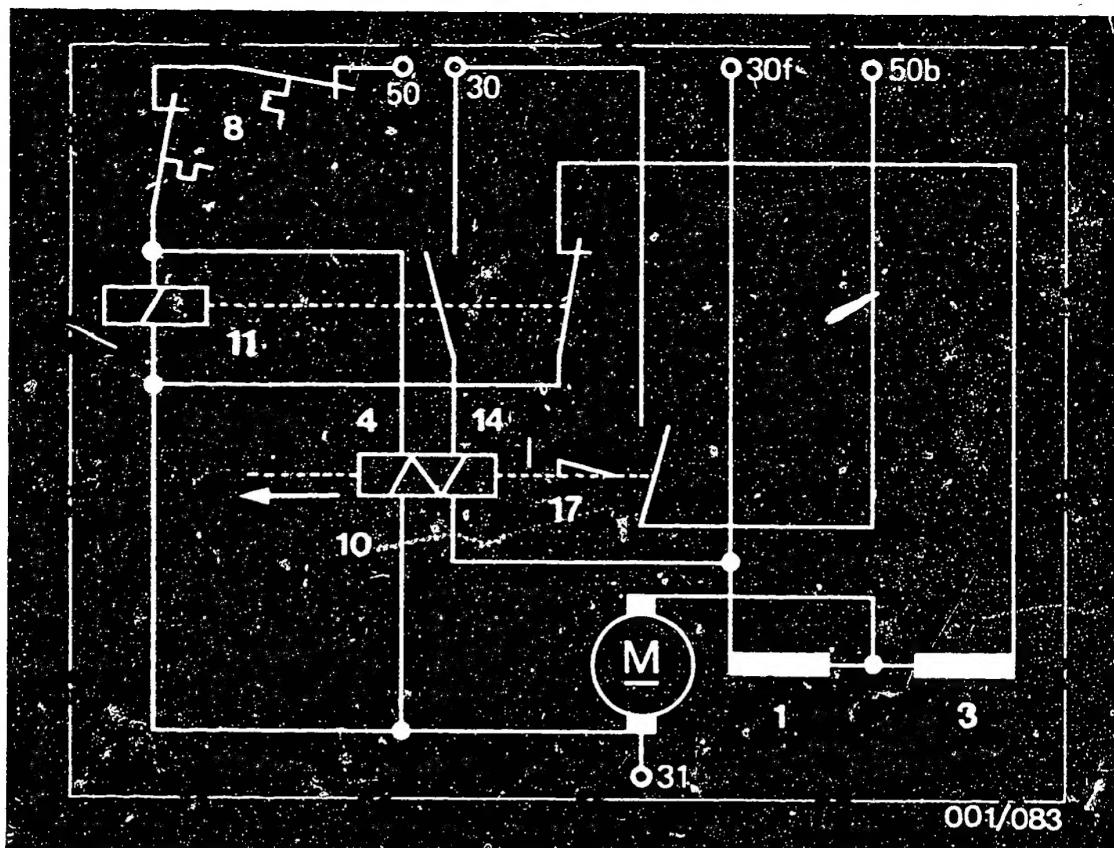


- | | | | |
|----|-----------------|----|------------------------------|
| 1 | Series winding | 11 | Power relay |
| 3 | Brake winding | | (control relay) |
| 4 | Holding winding | 14 | Pull-in and opposing winding |
| 8 | Thermo-switch | 17 | Detent pawl |
| 10 | Solenoid switch | 18 | Capacitor |

Circuit diagram for starting motors (single starting motors)

0 001 600 006	Item 13 only in
010	0 001 608 006
	007
601 001	Item 8 only in
007	0 001 601 020
020	023
023	608 006
608 006	
007	





- | | | | |
|---|-----------------|----|------------------|
| 1 | Series winding | 10 | Solenoid switch |
| 3 | Brake winding | 11 | Power relay |
| 4 | Holding winding | | (control relay) |
| 8 | Thermo-switch | 14 | Pull-in and |
| | | | opposing winding |
| | | 17 | Detent pawl |

Circuit diagram for starting motors (parallel starting motors)

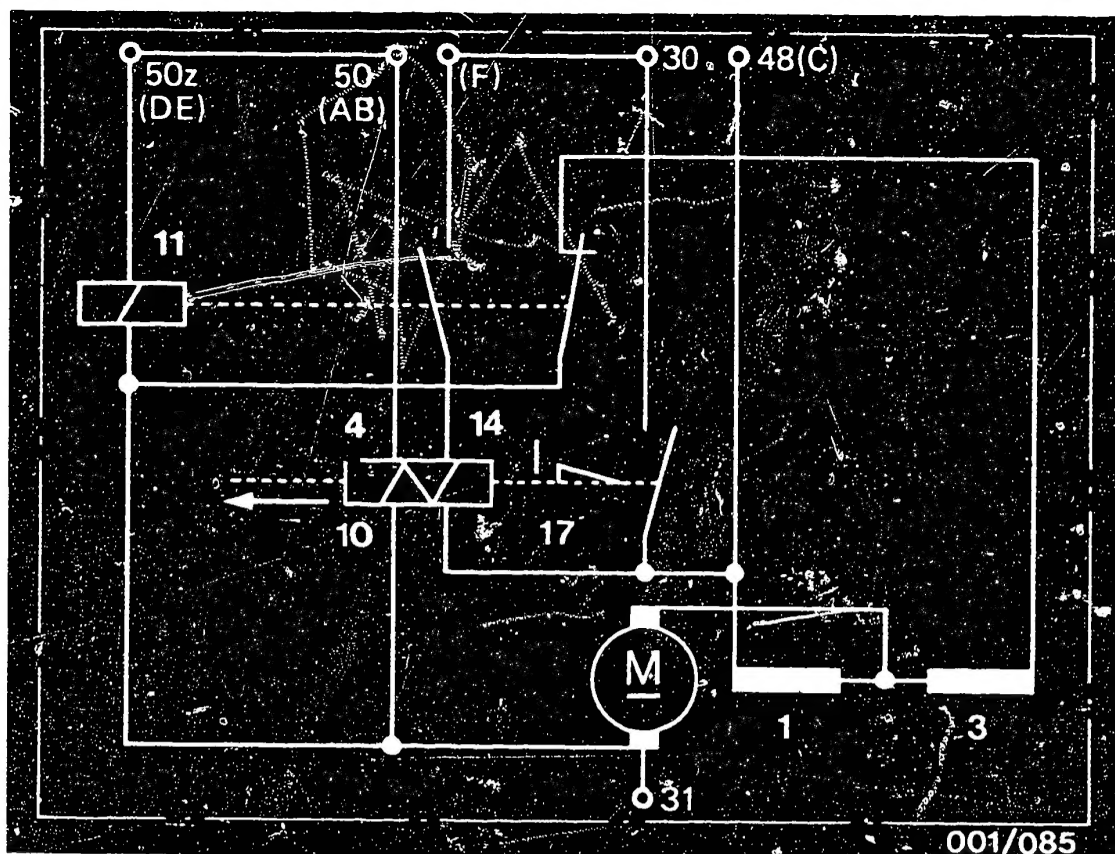
0 001 601 009	Item 8 only in
010	0 001 601 019
013	611 001
016	
019	
603 002	
611 001	

A9

Circuit diagrams

T-type starting motor 0 001 6 ..., 24 V





- | | | | |
|----|-----------------|----|------------------|
| 1 | Series winding | 11 | Power relay |
| 3 | Brake winding | | (control relay) |
| 4 | Holding winding | 14 | Pull-in and |
| 10 | Solenoid switch | | opposing winding |
| | | 17 | Detent pawl |

Circuit diagram for starting motors (single starting motors)

0 001 613 001



4. General information

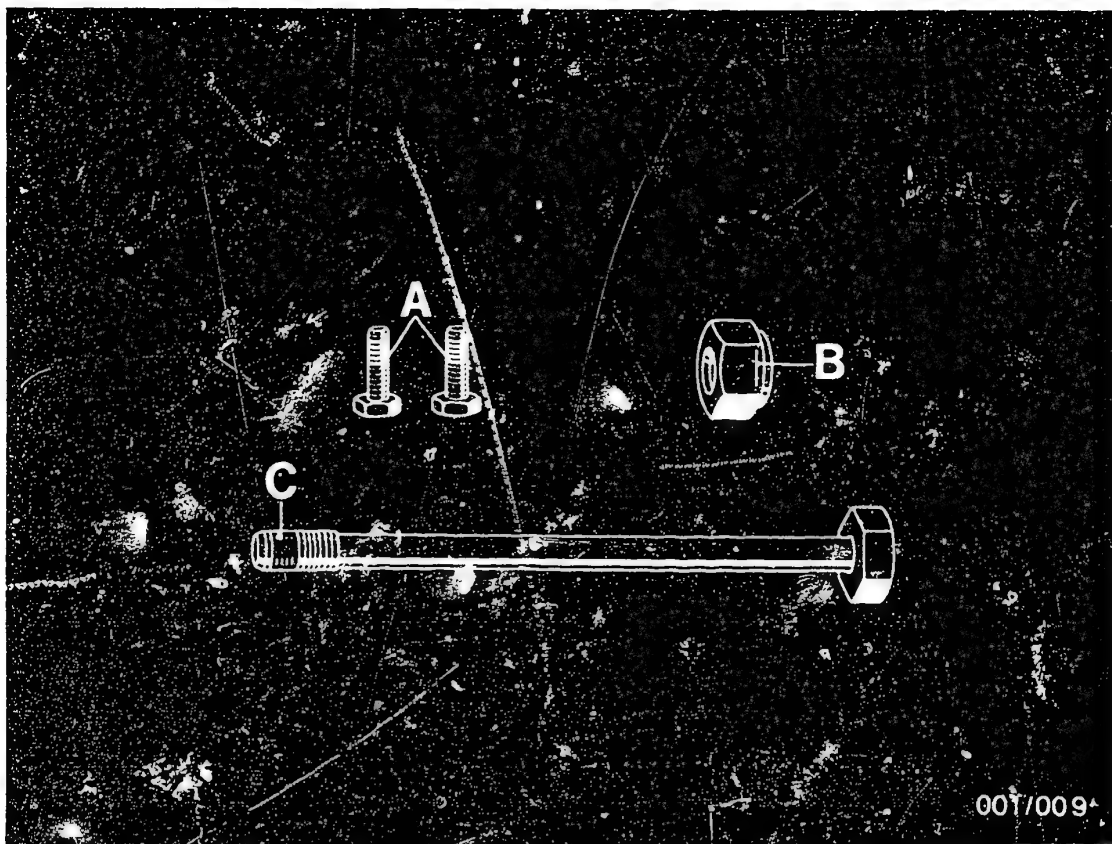
As regards the construction of T-Type starting motors a distinction is made between TB, TF and TE starting motors. TF and TE starting motors are equipped with an intermediate transmission. All starting motors are otherwise of identical construction.

The figures in () refer to the exploded view from the TB starting motor service-parts microfiche 0 001 608 003 on the last page of this repair manual.

The specified lubricants must be used for lubricating the starting motors. If other lubricants are used, the reliable operation of the starting motor is not guaranteed.

Professional repairs are only possible using the correct tools and measuring instruments. We therefore advise you only to use the tools listed.





In new T-Type starting motors 0 001 60..., 0 001 61..., tab washers or locking washers are no longer used in some places to lock nuts and bolts. Self-locking nuts and bolts are fitted instead. See illustration for examples.

A = Micro-encapsulated*bolts - self-locking due to flexible plastic coating on thread.

B = Uni-Stop nut* - self-locking due to compressed slot.

C = Bolt with Loc-wel strip* - self-locking due to flexible plastic strip on thread.

* = Manufacturer's designation



Cleaning the parts

Clean armatures, windings, plain bearings and solenoid switches only with compressed air (max. 4 bar) and a clean rag. Do not use liquid cleaning agent.

Other parts, such as screws, bolts, armature shafts, clutch discs, ball bearings, starting-motor pinions etc. can be washed in commercially available cleaning agent of low inflammability.
Do not inhale vapours.

Caution:

Parts which have been washed must be dried thoroughly since, otherwise, gases may form in the starting motor when it is later sealed - danger of explosion.

Observe local safety regulations!



5. Necessary test equipment and tools

Test equipment

Test panel	0 681 103 400 (formerly EFAW 81...)
Transformer panel	0 681 103 402 (formerly EFAW 82..)
Interturn-short-circuit tester	0 681 169.. (formerly EFAW 90..)
or	0 681 169.. (formerly EFAW 95..)
High-tension insulation tester	Commercially avail- able e.g. HISO IMP 68- 5000 E/S
Ohmmeter (diode tester)	WPG 012.00 (formerly 0 681 101 402)
or	
Resistance-measuring bridge	Commercial avail- able
Undercutting saw	KDAW 9998 (formerly EFAW 10)
Torquemeter, 33...300 Nm (3.3...30 kgfm) for measuring the slipping torque	KDAL 5476 (formerly EF 2368 B)
Dial indicator	1 687 233 011 (formerly EFAW 7)
Magnetic instrument stand T-M 1	4 851 601 124 (formerly EW/1151 B1/0 601 980 001)

Tools

Clamping support with pole-shoe screwdriver	KDAW 9999 (formerly EFAW 9)
Spring collet	KDAW 9995 (formerly EF 3104)
Two- or three-arm puller	
Clamping width up to approx. 150 mm	} Commercially avail- able
Clamping depth up to approx. 150 mm	
Arbor press	

A14

Test equipment and tools

T-Type starting motors 0 001 6..., 24 V

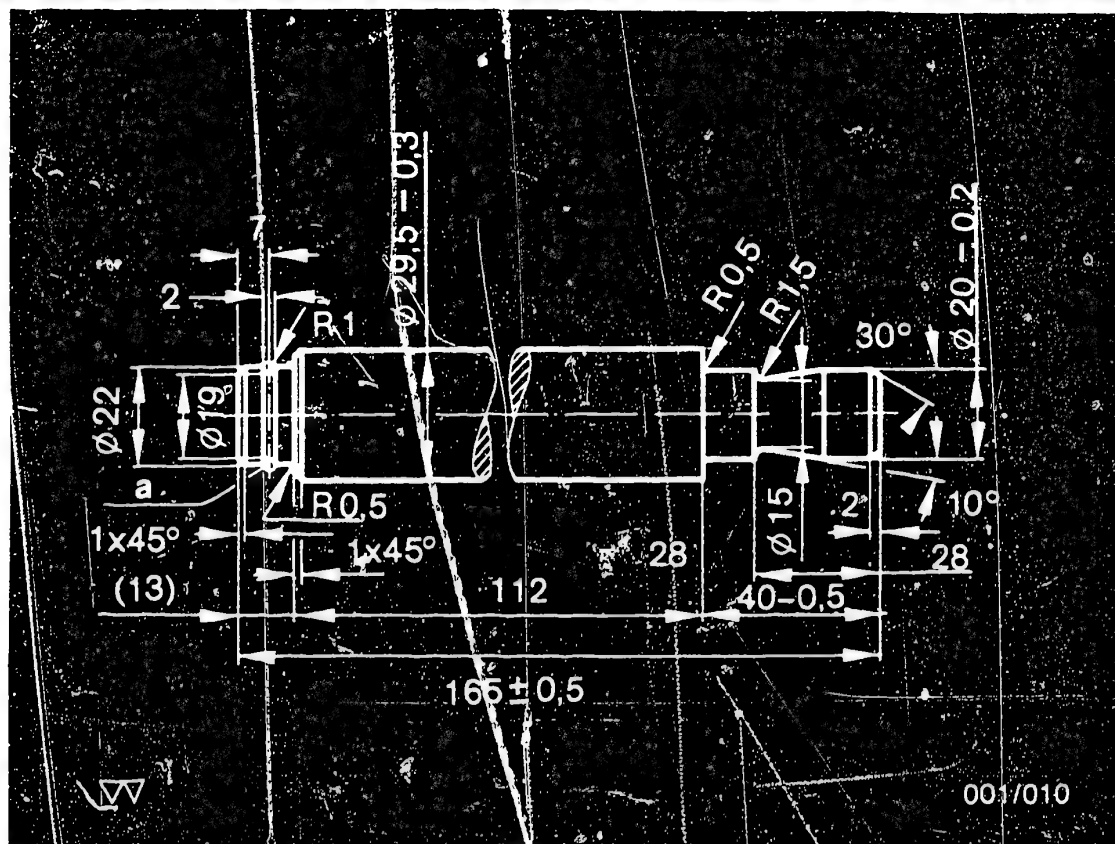


Tools for user fabrication

Drawings can be requested from KH/VSK.

Torquemeter 1.0...2.5 Nm (10...25 cmkgf) for measuring the overrunning torque	EFAL 54
Thrust member for armature on undercutting saw	EFAL 46
Clamping bolt for drive spindle with multi- disc clutch	EFAL 48
Press-in mandrel	EFAL 51
Press-out mandrel	EFAL 52
Assembly wrench for drive spindle with multi-disc clutch	EFAL 53
Pressing-out device for roller bearing in drive-end-bearing housing	EFAL 56
Caulking tool for round nut of drive spindle	EFAL 58
Finishing tool	EFAL 63
Press-in mandrel	EFAL 64
Support for drive spindle when caulking	EFAL 67
Sleeve for supporting drive shaft when adjusting torque	EFAL 68
Drilling jig for centering M 4 thread after fitting new bushing in commutator end shield	EFAL 69
Drive-in mandrel for fitting winding	EF 2529
Clamping bolt for arbor-press tool without clamping pin with M 12 female thread	KDLI 6010





a = O-ring

Tools for user fabrication

Press-in mandrel for needle-roller bearing

Material: St 37 alkaline-blackened

A16

Test equipment and tools

T-Type starting motors 0 001 6..., 24 V



6. Lubricants, sealants, insulating varnish

Special lubricating grease for plain and rolling bearings, pinion, washers, shafts and radial-lip-type oil seals

500 g can (VS 10832 Ft) 5 932 240 150

Silicone grease for multi-disc clutches

250 g tube (Ft 2 v 3) 5 700 082 025

Anti-corrosion oil

1.0 l can (01 41 v 2) 5 701 351 610

Silicone oil for lubricating wicks and lubricating felts and heavily stressed bearing points

0.50 l can (VS 13834 01) 5 962 260 605

Sealing putty for drive-end-bearing housing, closing cover, clamping band

500 g can (Kk 1 v 3) 5 703 452 150

Sealing compound ("Hylomar") for bolts, caps, drive-end-bearing housing, closing cover and clamping band

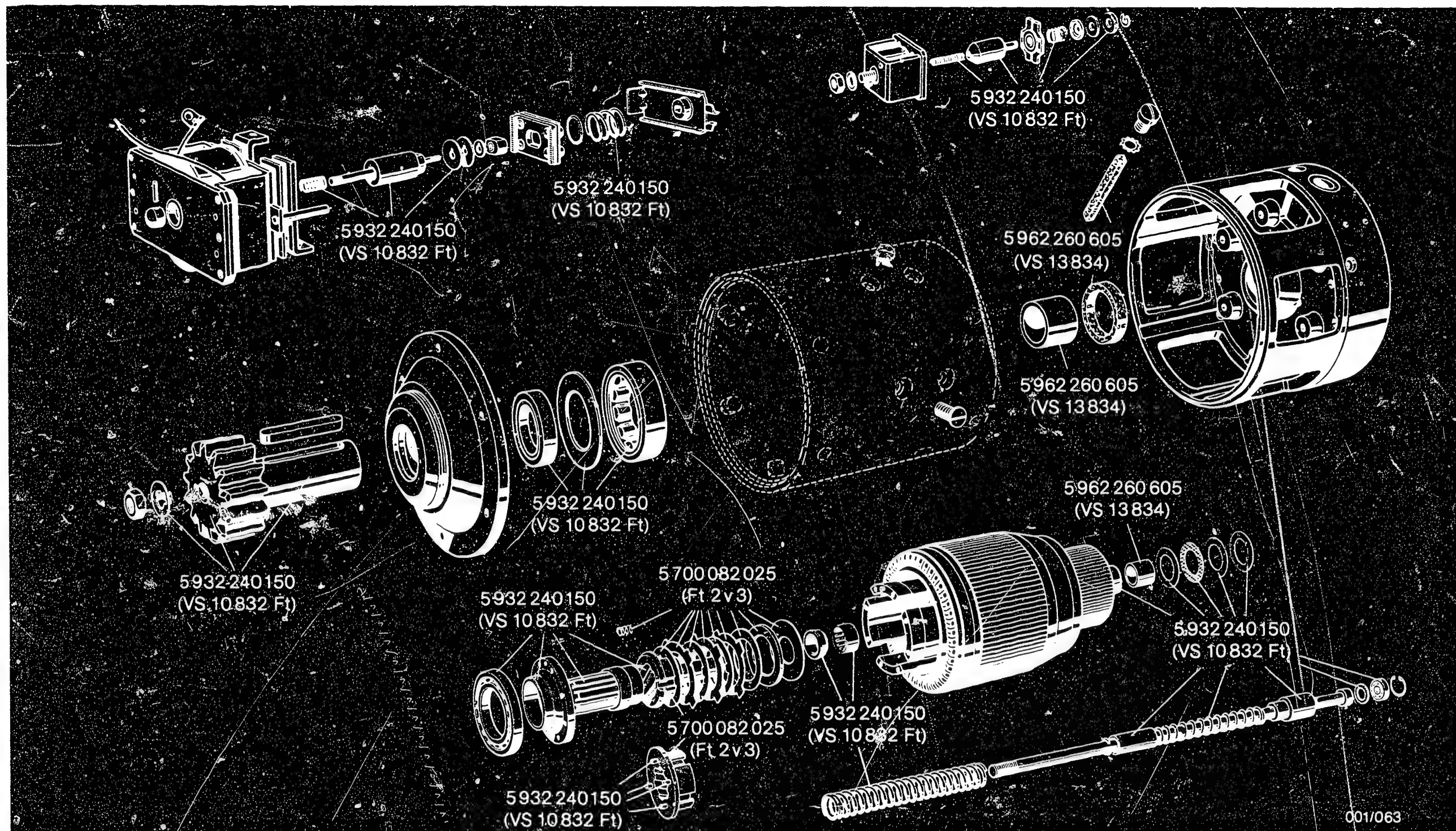
20 g tube (VS 9844 Kk) 5 927 350 002

Sealing varnish for special treatment of windings and coils and for sealing joints on outside of starting motors.

2.5 kg can (Fl 58 v 3) 5 722 719 505

1.0 kg can (Fl 58 v 3) 5 722 719 510





7. Lubrication table

General information

Oil all bare parts with anti-corrosion oil 5 701 351 610 (01 41 v 2). Where stated, grease the parts sparingly. Too much grease causes malfunctions at low temperatures.

Self-lubricating bearing bushings (Compo bushings) must never be cleaned in benzene or trichloroethylene. Before fitting, store for at least 24 hours in silicone oil 5 962 260 .. (VS 13834 OL). When replacing Compo bushings, remove old oil completely. Keep the commutator free of grease under all circumstances.

A19

Lubrication table

T-type starting motor 0 001 6 .., 24 V

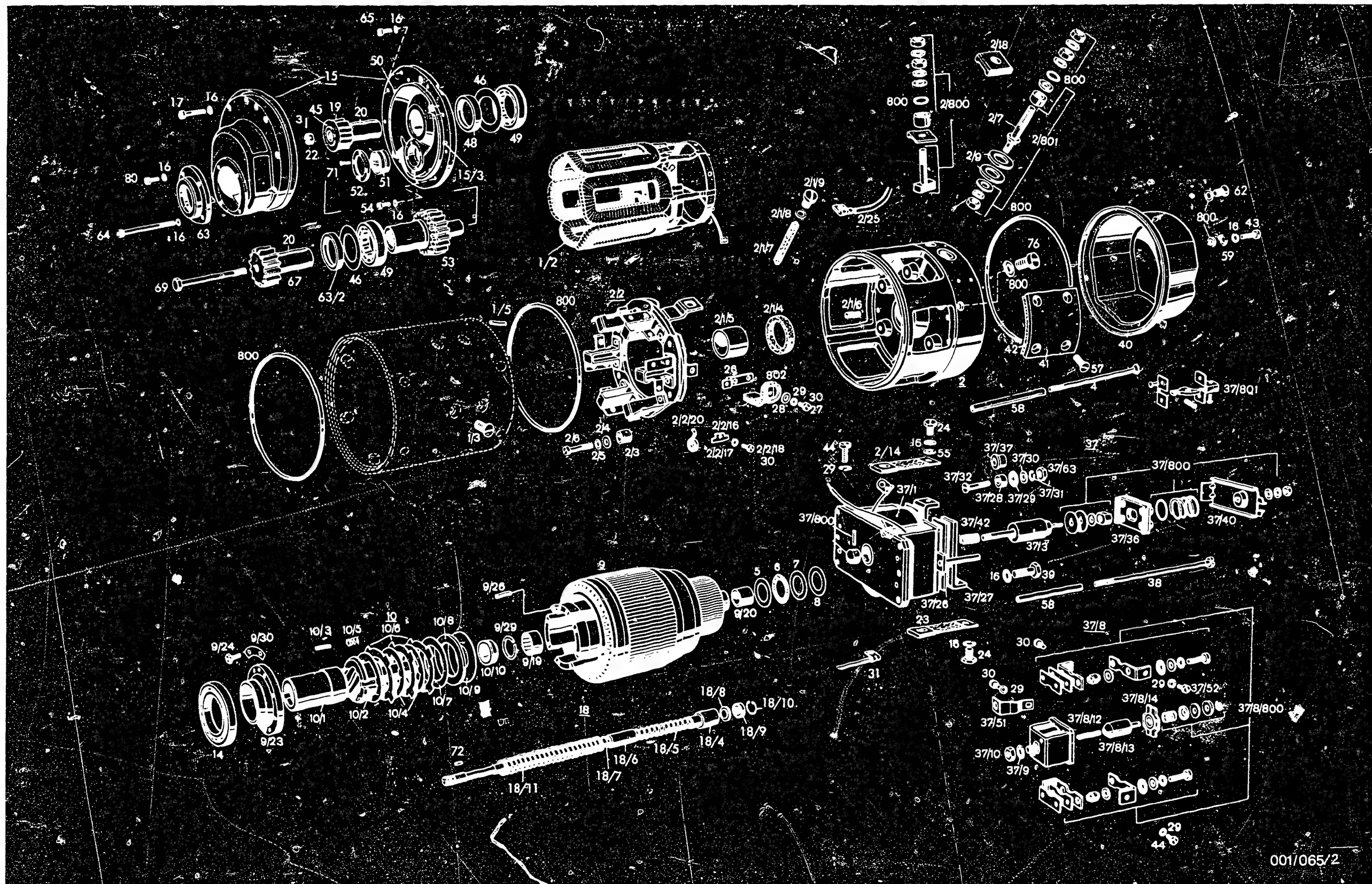


A20

Lubrication table

T-type starting motor 0 001 6 .., 24 V





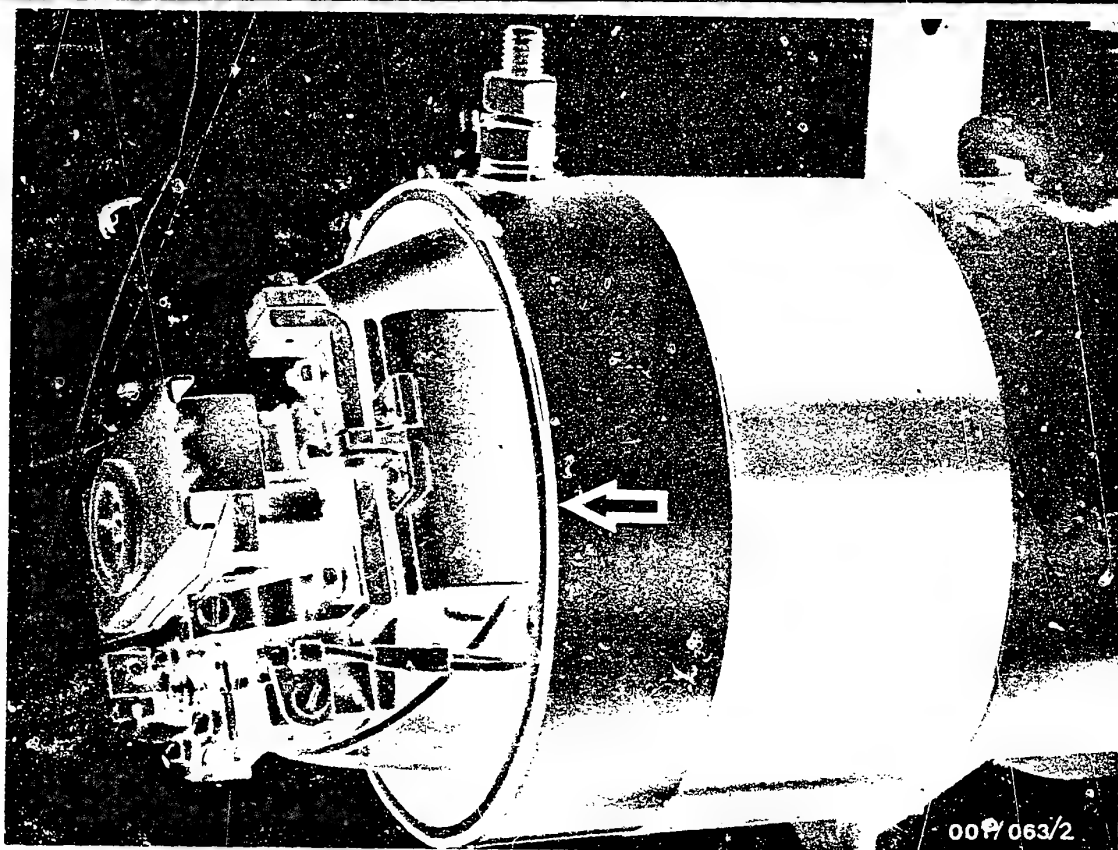
8. Exploded view

A23

T-Type starting motors 0 001 6.., 24 V

A24

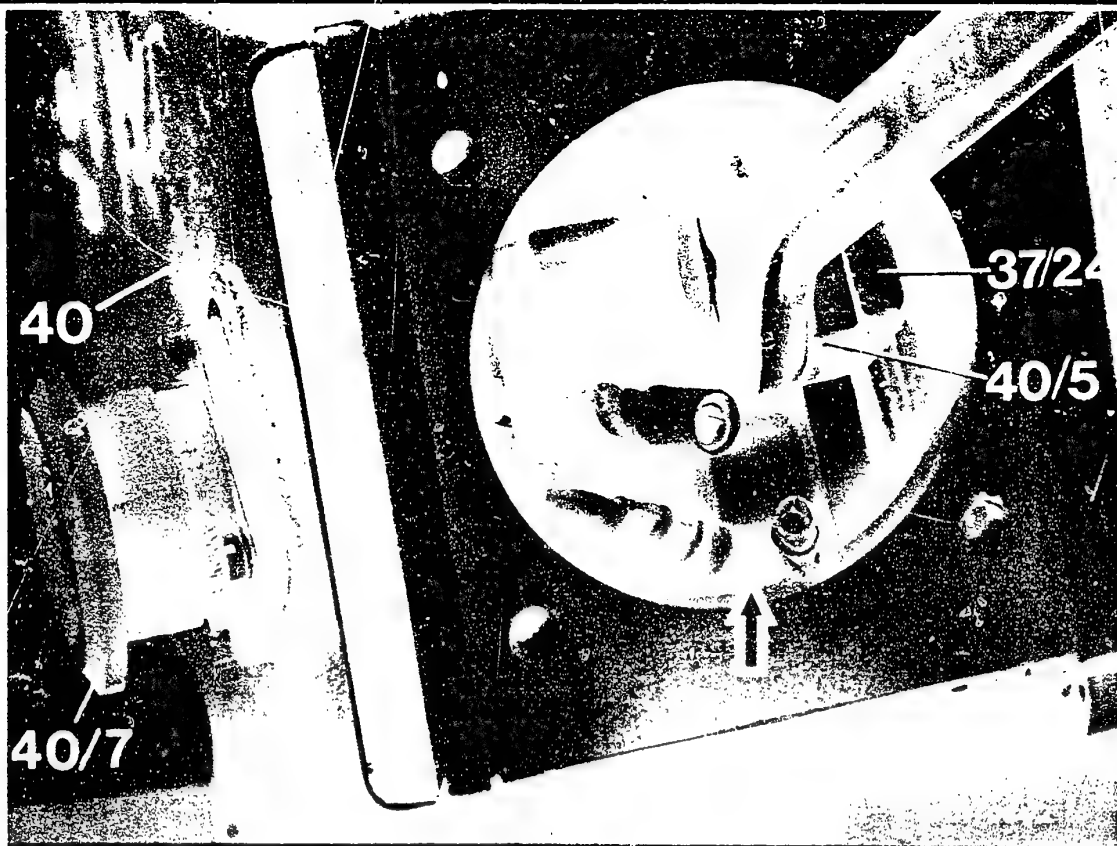
T-Type starting motors 0 001 6..., 24 V



9. Dismantling the starting motor

Mount starting motor in clamping support.
Remove closing cover (40) (already removed in picture)
and rubber seal ring if fitted (arrow).





Dismantling starting motor 0 001 613 001

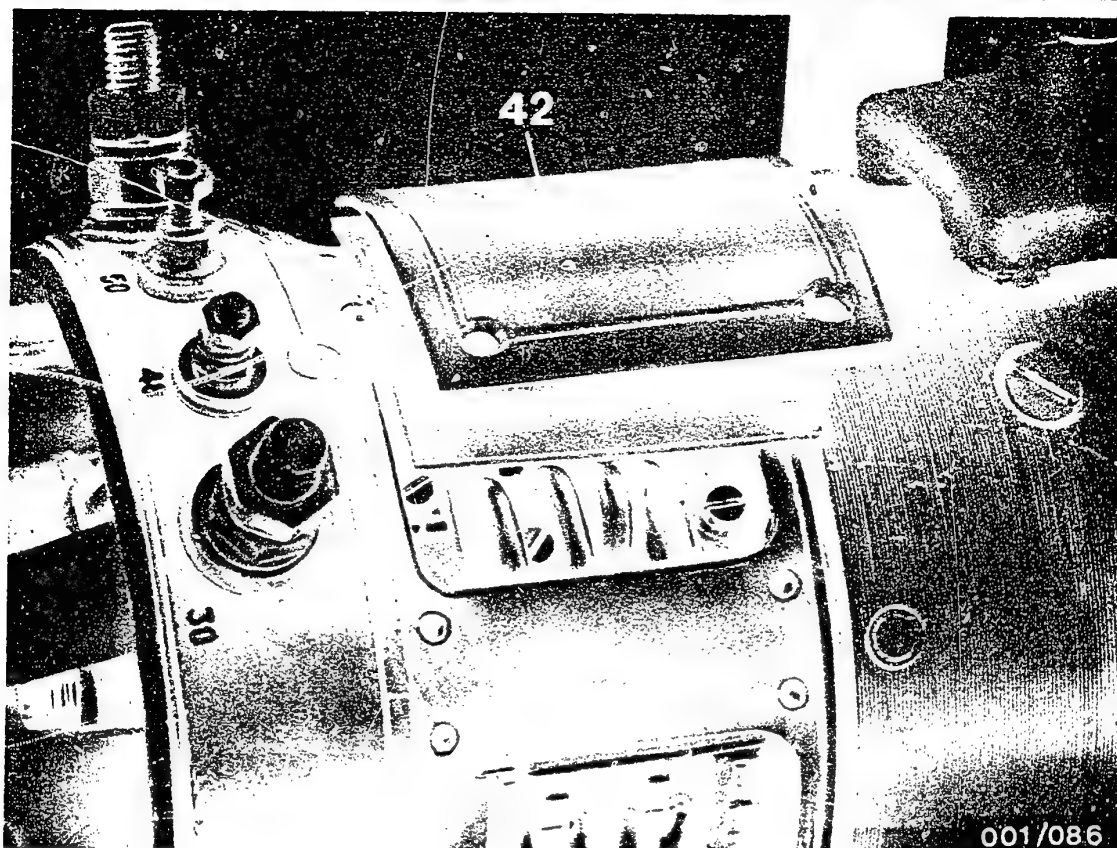
Mount starting motor in clamping support.
 Unscrew cover plate (removed in picture) from closing cover (40).
 Undo cable connections (plugs and sockets) (arrow) to socket (40/7).
 Unscrew flat cable (40/5) from contact bar (37/24) of solenoid switch.
 Now it is possible to unscrew the closing cover for the solenoid switch (40).

B2

Dismantling the starting motor

T-type starting motor 0 001 6 ..., 24 V





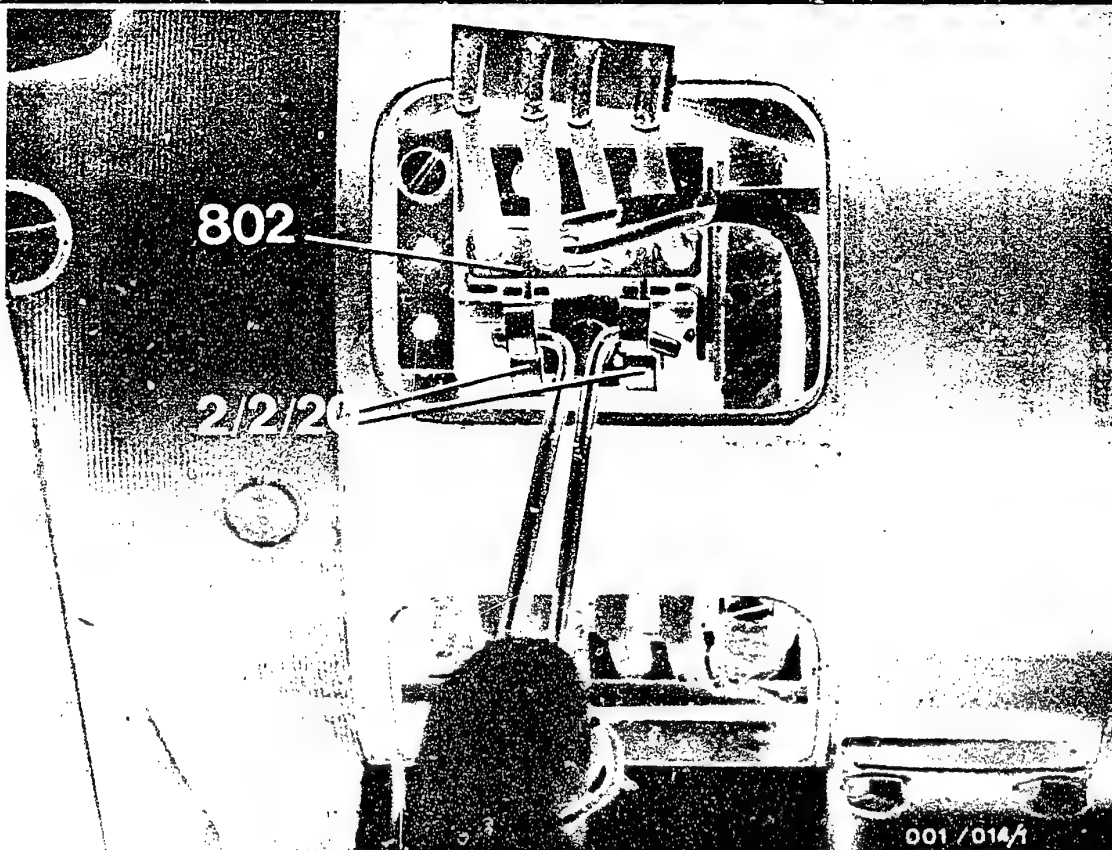
Take off cover plates, clamping band

Unscrew cover plates (42) or both clamping band halves with sealing insert (picture) or single-part clamping band.

B3

Dismantling the starting motor
T-type starting motor 0 001 6 ..., 24 V





Remove carbon brushes

Screw off carbon-brush terminals.

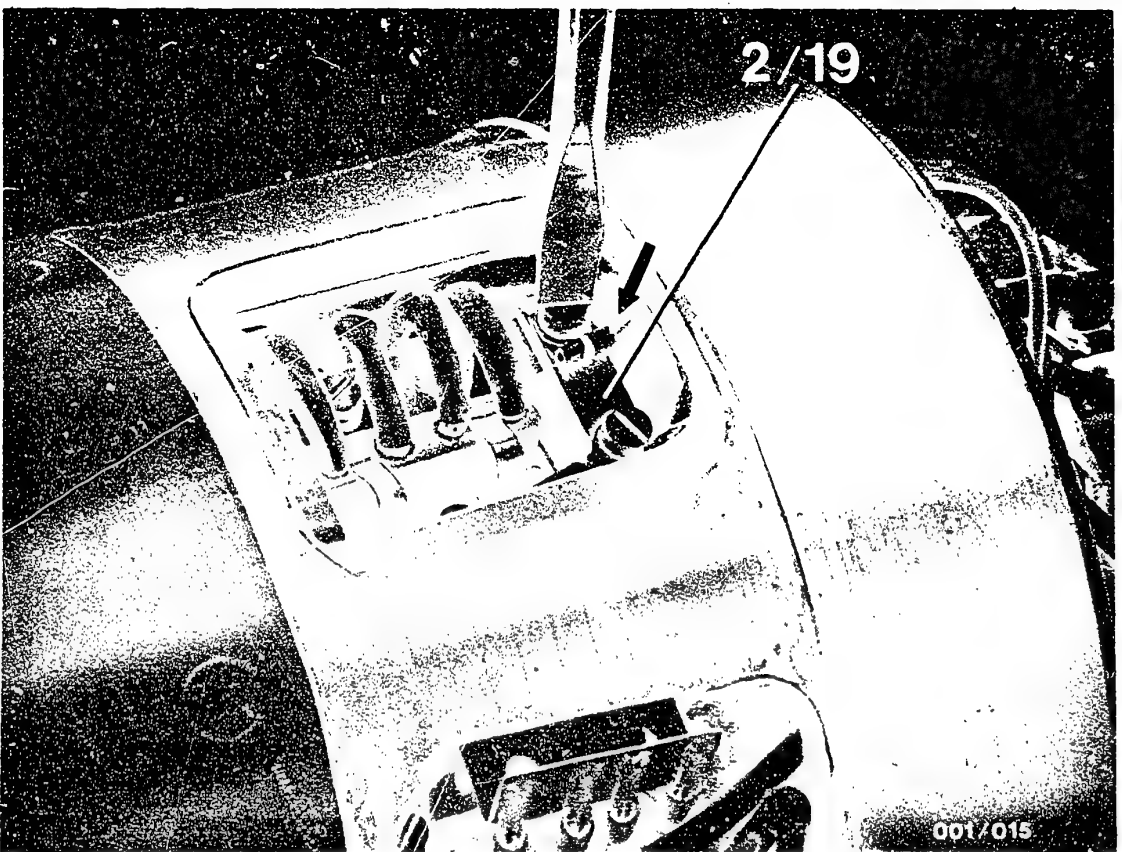
Lift up compression springs (2/2/20) using suitable wire hook and withdraw carbon brushes (802).

B4

Dismantling the starting motor

T-Type starting motors 0 001 6.., 24 V





Undo connections:

Remove electric connectors and screw connections from the excitation-winding bar (2/19).

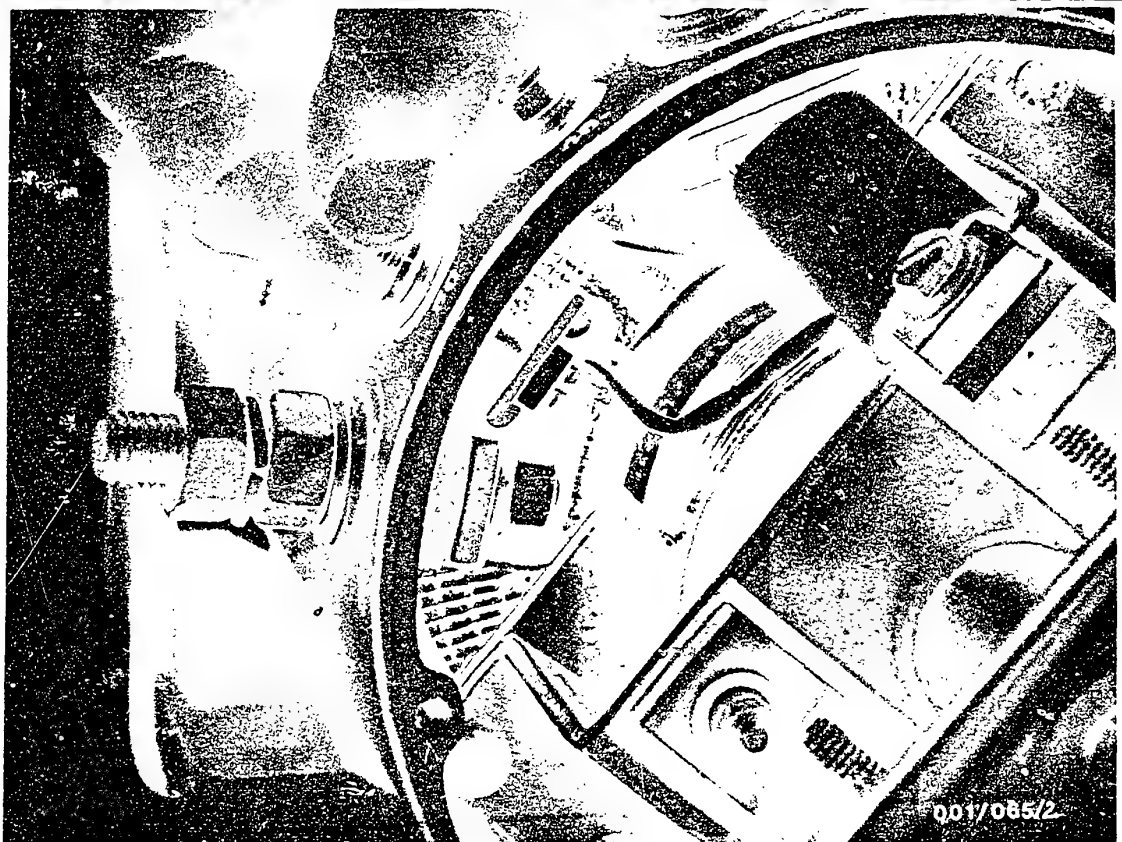
Picture: Red terminal of solenoid switch holding winding. (Arrow).

B5

Dismantling the starting motor

T-Type starting motors 0 001 6.., 24 V





Remove terminal 50

Remove terminal 50 (parts set) entirely. Note order of washers and insulating parts.

Note:

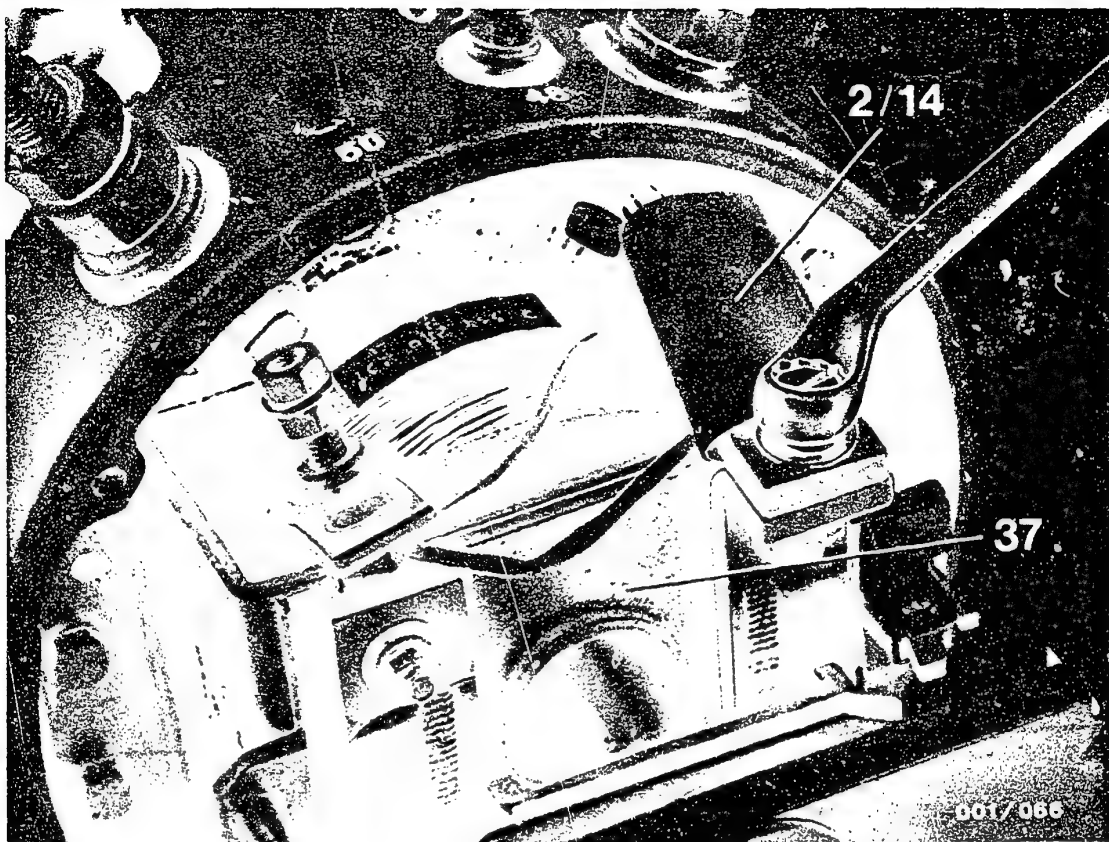
It is advisable afterwards to loosely assemble the individual parts in the correct order.

B6

Dismantling the starting motor

T-Type starting motors 0 001 6..., 24 V





Undo connections

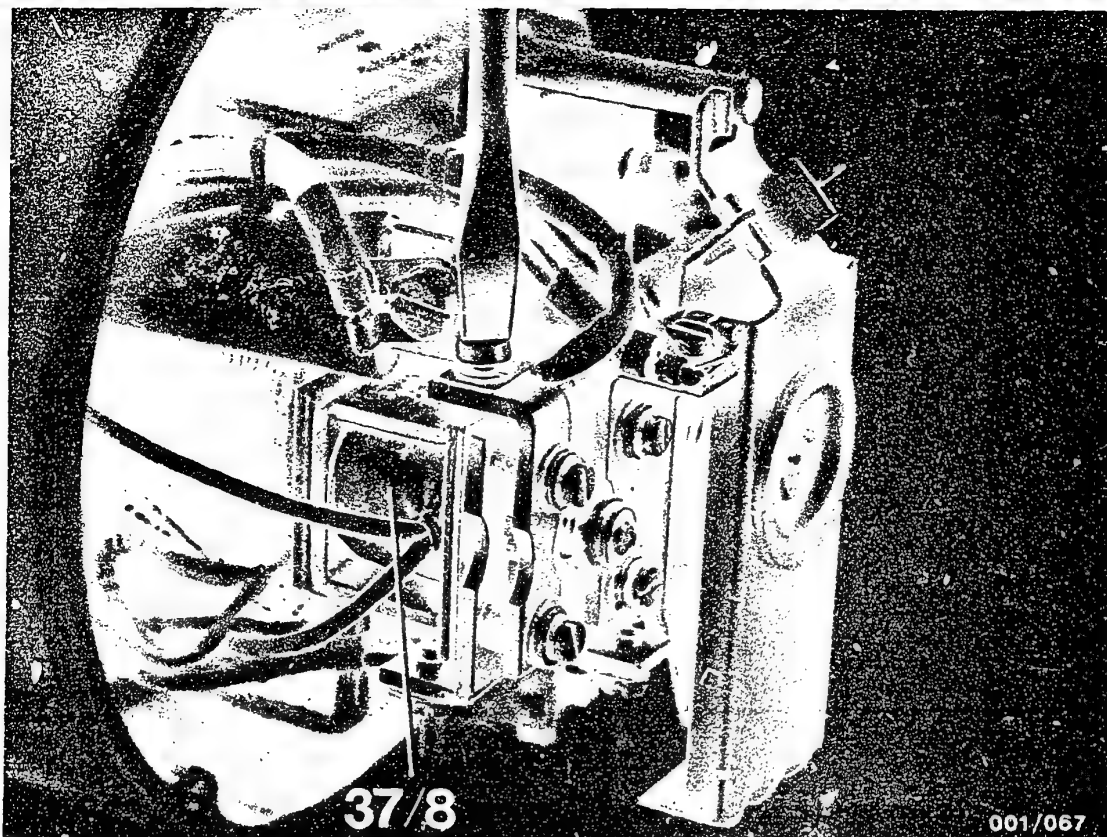
Unscrew cable (2/14) from terminal 30 (parts set) to contact bar of solenoid switch (37).

B7

Dismantling the starting motor

T-Type starting motors 0 001 6.., 24 V





Undo connections

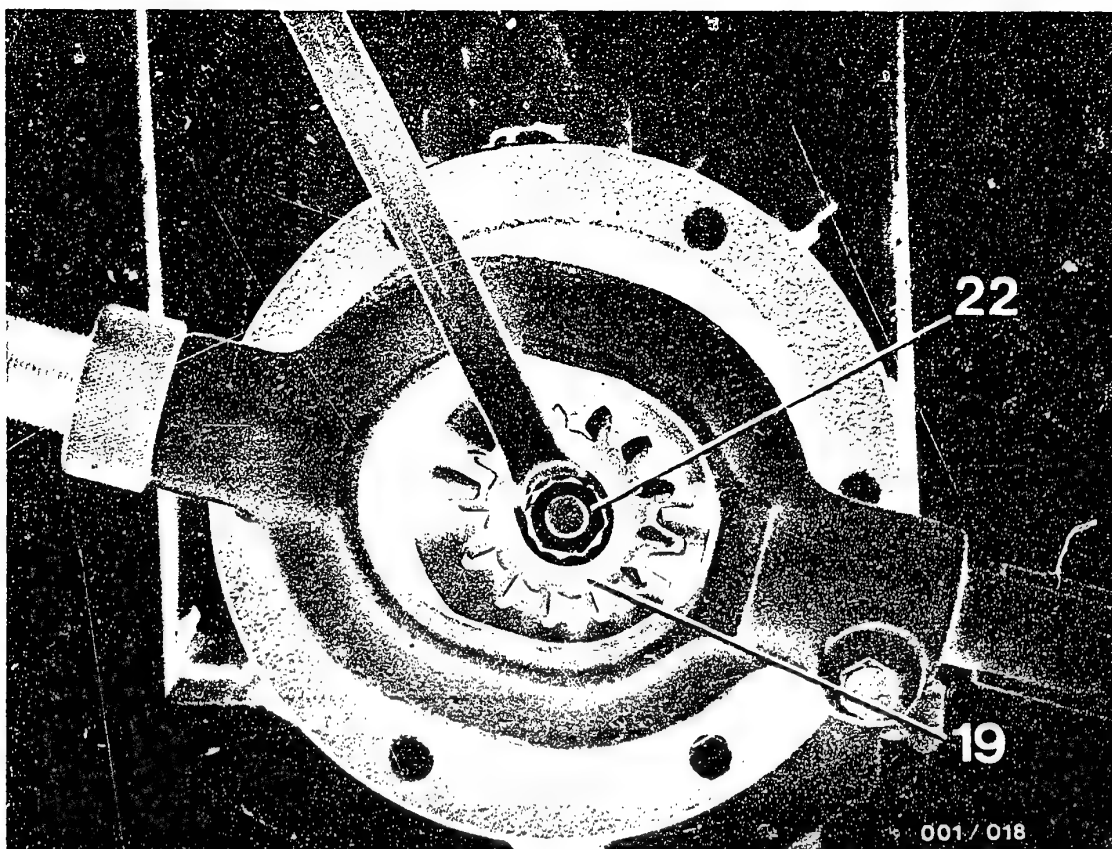
Unscrew connecting cable of brake winding (arrow) from contact bar of power relay (37/8).

B8

Dismantling the starting motor

T-type starting motor 0 001 6 ..., 24 V





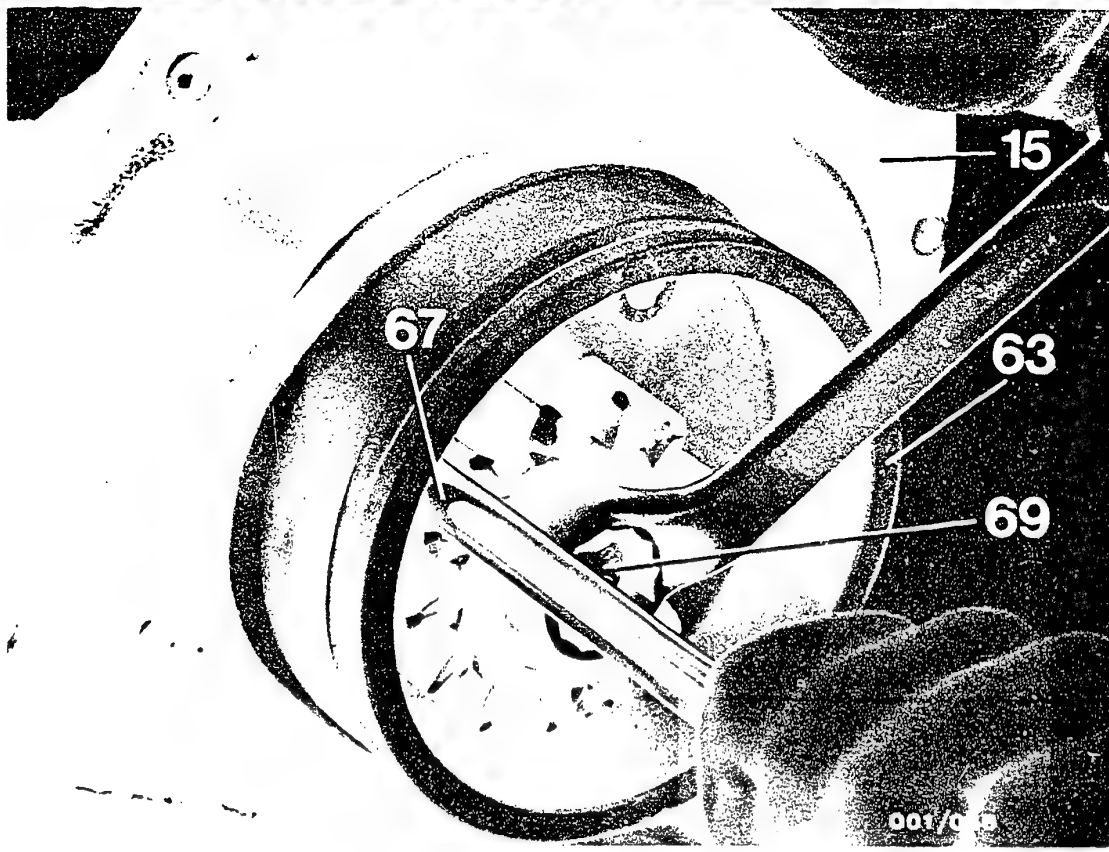
Remove starting-motor pinion - general

Lock starting-motor pinion (19) in position using torque-meter KDAL 5476. Screw off nut (22) - (on TB starting motors 0 001 600 ..., 0 001 601 ..., Uni-Stop nut) - (on TF starting motors 0 001 608 ..., .. 611 ..., .. 613..., and TE starting motors 0 001 602 ..., .. 603 ..., bolt with Loc-wel strips).

Withdraw starting-motor pinion (19). If necessary, remove parallel key from engagement shaft.

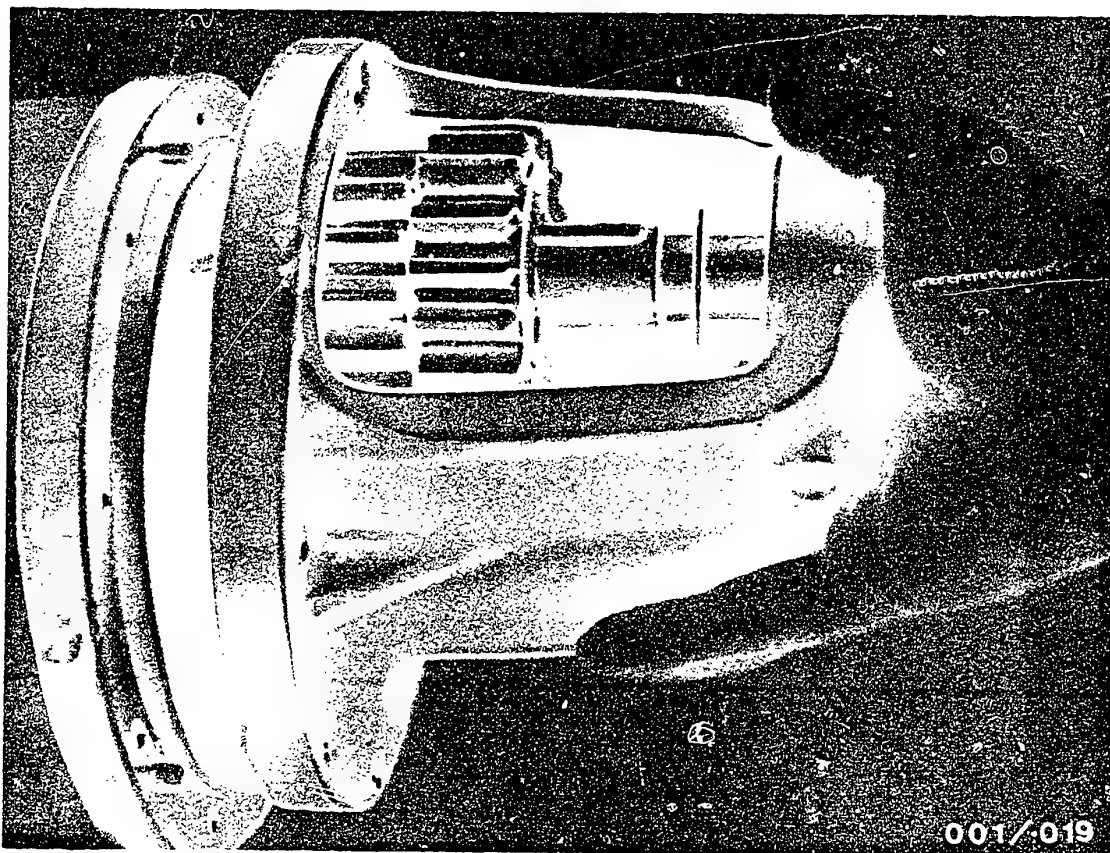
Picture: TB starting motor 0 001 600 ..., 0 001 601 ..





Remove starting-motor pinion, starting motor
0 001 613 001.

Place suitable round stock between starting-motor pinion (67) and bearing end plate (63) (see picture). This blocks the starting-motor pinion when loosening the bolt (69). Withdraw pinion and unscrew bolts from bearing end plate (63). The drive-end-bearing housing (15) can now be screwed off.



001/019

Dismantle intermediate transmission

TE starting motors 0 001 602 503 ...

Unscrew bolts of intermediate transmission.
Press in with your hand the mounting bracket of the starting-motor solenoid core (not shown). In doing so, the intermediate transmission is pushed out and can be removed (see picture).

Note the friction washers on the intermediate-transmission shaft.

Caution

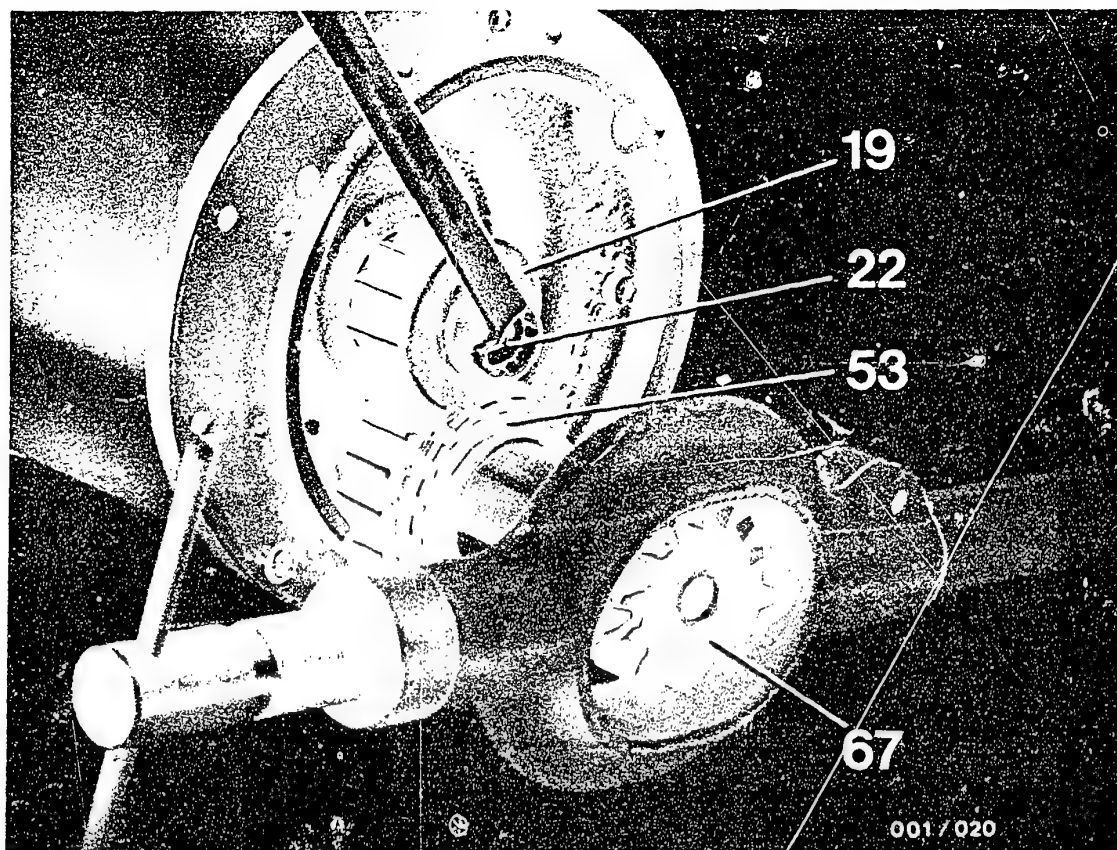
Check the sintered bearing bushings for the armature shaft in the intermediate transmission (47). Defective sintered bearing bushings may only be replaced together in both drive-end-bearing housings (15) and (50), and must be turned out so that they align. This work can only be performed in the repair workshop PLB or NUW1. Send in either both drive-end-bearing housings (15) and (50) or complete starting motor.

B11

Dismantling the starting motor

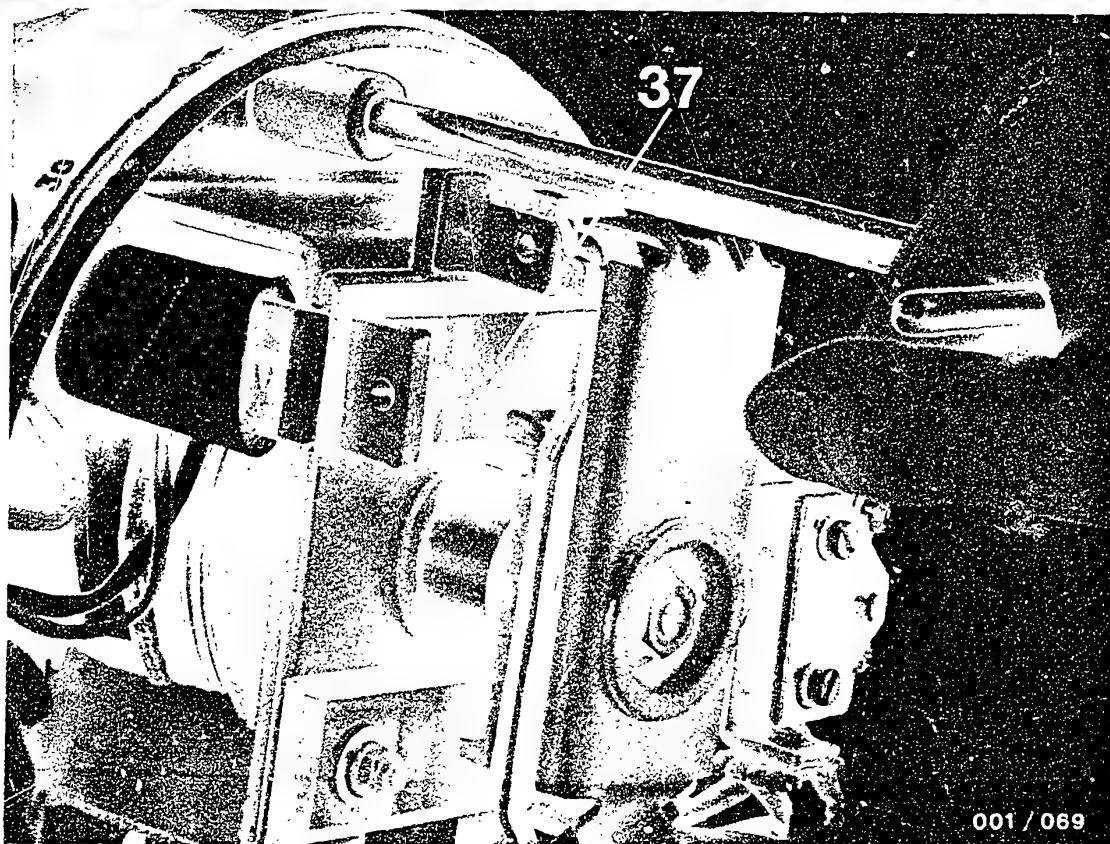
T-type starting motor 0 001 6 .., 24 V





Dismantle intermediate transmission

TF starting motors 0 001 608 ..., .. 611 ..., .. 613 ...
 Lock starting-motor pinion (67) in position using
 torquemeter KDAL 5476 and remove fastening screw.
 Remove outer drive-end-bearing housing (15) (drive-
 end-bearing housing already removed in picture).
 Re-insert starting-motor pinion (67) and lock in position
 using torquemeter KDAL 5476. Unscrew Uni-Stop nut or
 castle nut (22). Remove starting-motor pinion (53)
 together with starting-motor pinion (19). Remove
 parallel key from engagement shaft.



Remove solenoid switch

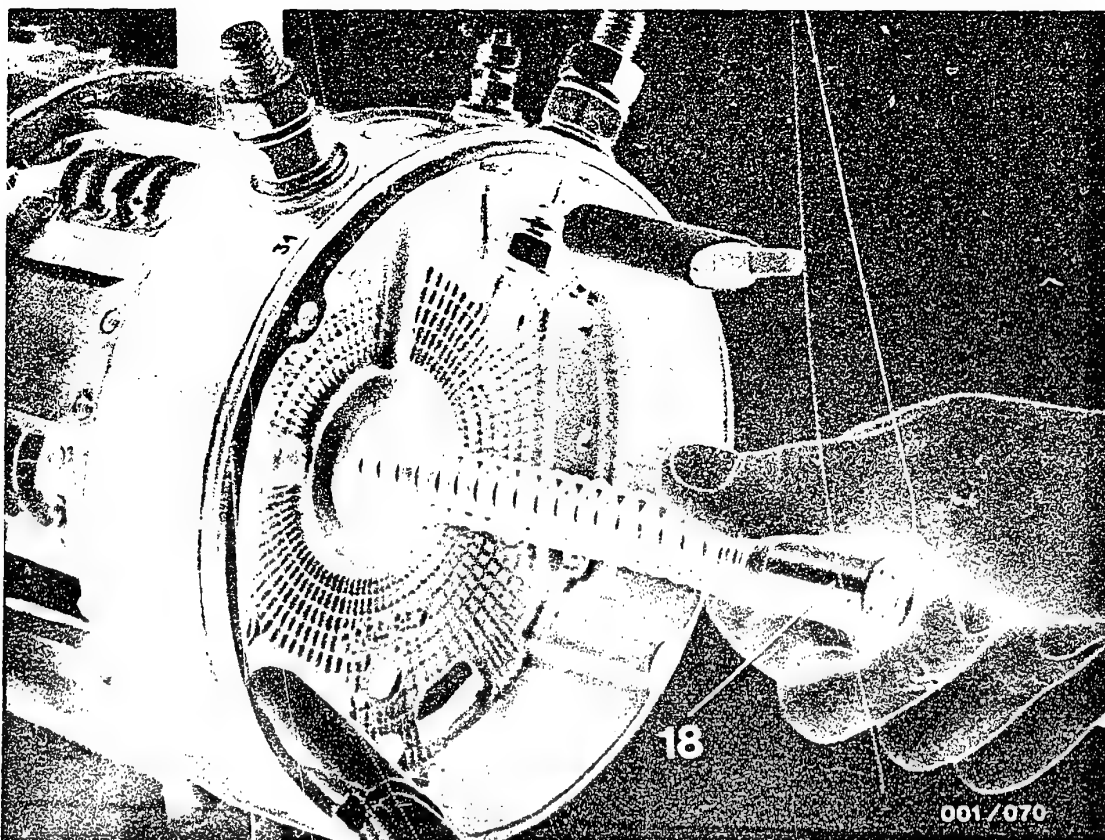
Unscrew solenoid switch (37) (see picture). Armature shaft (engagement shaft) becomes visible.

B 13

Dismantling the starting motor

T-type starting motor 0 001 6 .., 24 V





Remove armature shaft

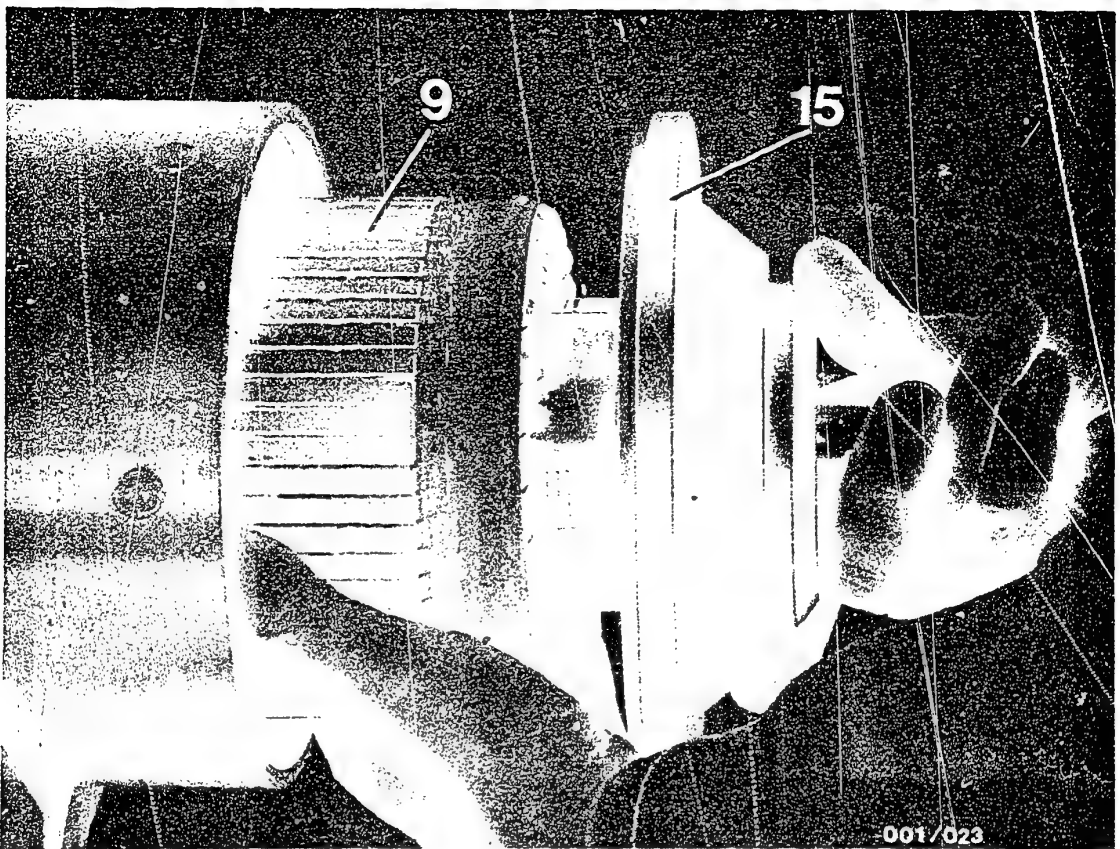
Withdraw armature shaft (18) - (engagement shaft) - in the direction of the commutator end shield (see ill.).

B14

Dismantling the starting motor

T-Type starting motors 0 001 6..., 24 V





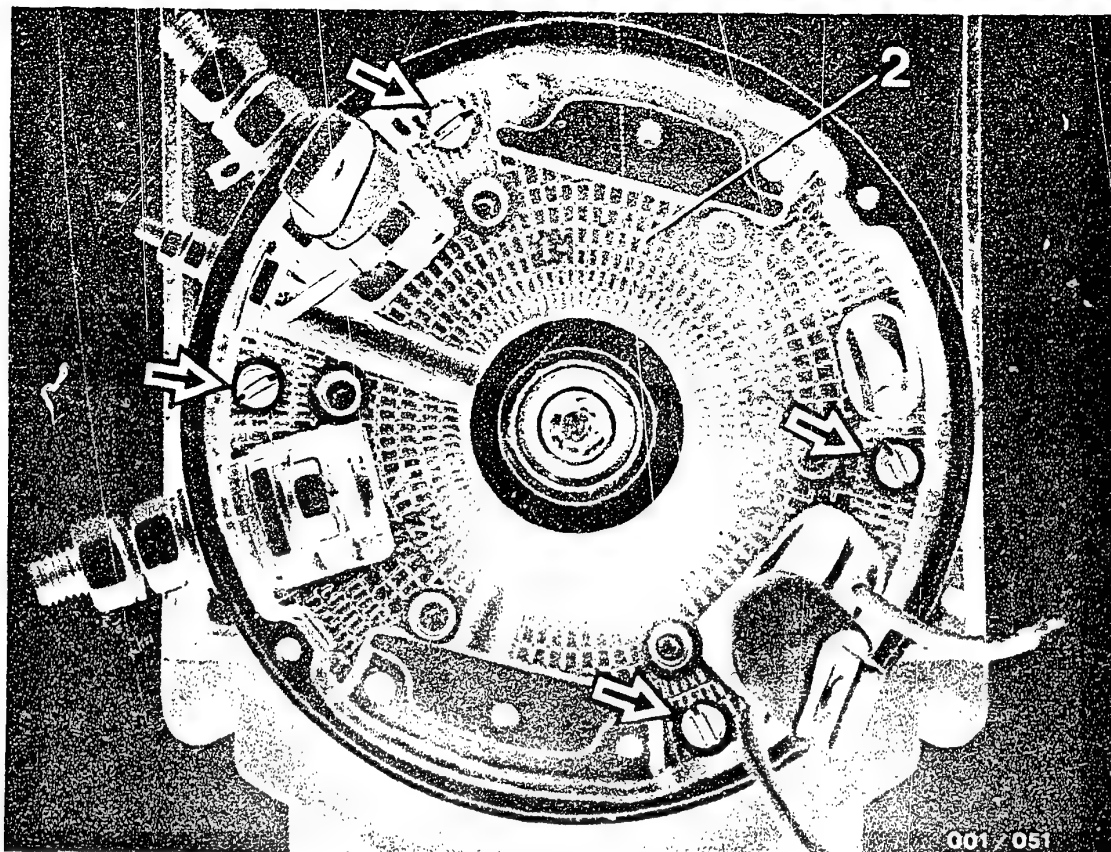
Remove drive-end-bearing housing (TB/TF)

Screw off cover of drive-end-bearing housing (15) (TB starting motor).

In case of TB starting motor, pull outer drive-end-bearing housing (15) together with armature (9) out of stator frame. In case of TF starting motor, pull inner drive-end-bearing housing (15) together with armature (9) out of stator frame.

Loosen drive-end-bearing housing (15), if necessary, by careful blows with a rubber mallet.





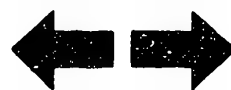
Remove commutator end shield

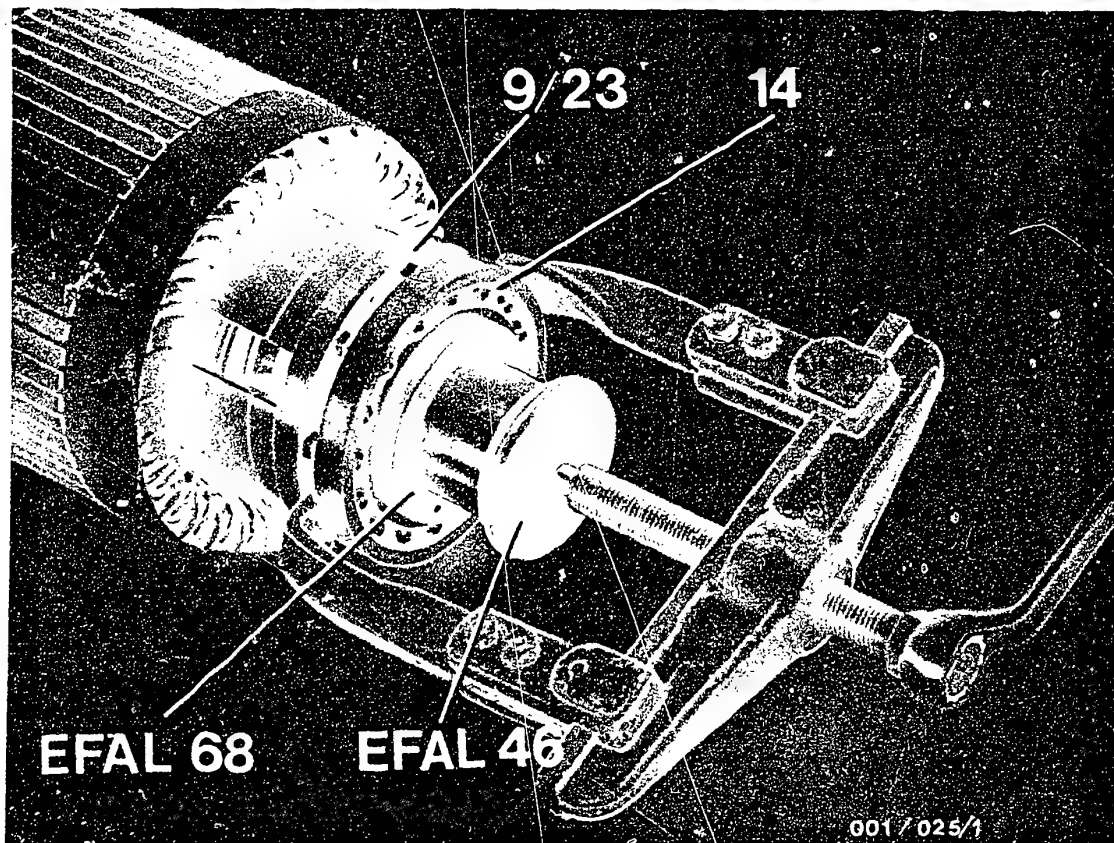
Screw out fastening screws (arrows) of commutator end shield (2) and carefully remove commutator end shield - do not damage insulation of connecting wires.

B 16

Dismantling the starting motor

T-Type starting motors 0 001 6..., 24 V





Pull off deep-groove ball bearing

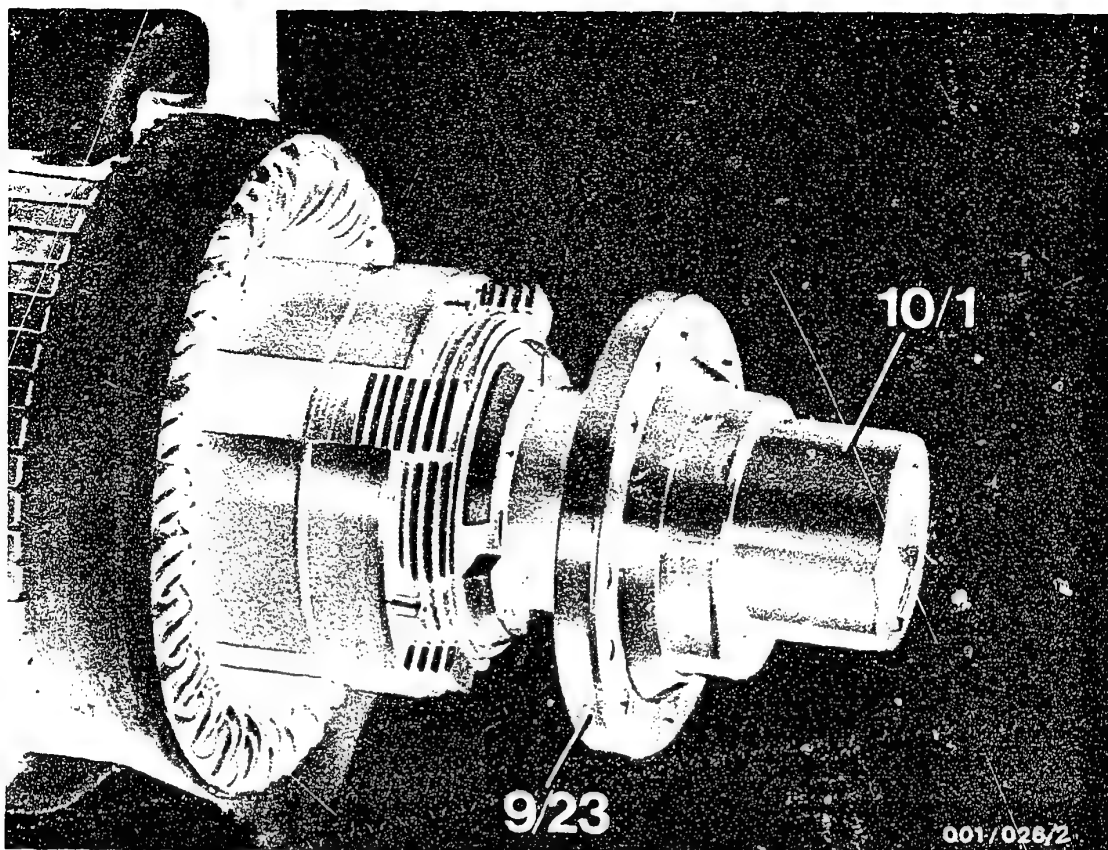
Mount armature in clamping support. Pull off deep-groove ball bearing (14) from intermediate bearing (9/23) using commercially available claw-type puller. Use tools EFAL 46 and EFAL 68 - see picture.

B17

Dismantling the starting motor

T-Type starting motors 0 001 6..., 24 V





Remove drive spindle complete

Screw out 8 micro-encapsulated bolts with which the intermediate bearing (9/23) is fastened.

Pull off intermediate bearing (9/23) from drive spindle (10/1) using commercially available claw-type puller.

Note:

On older T-Type starting motors 0 001 6.. the fastening screws of the intermediate bearing are still secured by tab washers and the intermediate bearings are not pinned. When re-assembling, discard these tab washers and fit micro-encapsulated bolts instead!



10. Cleaning the parts

Clean armatures, windings, plain bearings and solenoid switches only with compressed air (max. 4 bar) and a clean rag. Do not use liquid cleaning agent.

Other parts, such as screws, bolts, armature shafts, clutch discs, ball bearings, starting-motor pinions etc. can be washed in commercially available cleaning agent of low inflammability.

Do not inhale vapours.

Caution:

Parts which have been washed must be dried thoroughly since, otherwise, gases may form in the starting motor when it is later sealed - danger of explosion.

Observe local safety regulations!

C1

Cleaning parts - safety regulations

T-Type starting motors 0 001 6.., 24 V



Working with dangerously inflammable or health-hazardous agents

Benzine, tri- or perchloroethylene are approved for the washing of motor vehicle electrical parts which are to be repaired. Both cleaning agents must be used cautiously since they are dangerous.

Benzine, acetone or ethanol are combustible liquids and can explode when mixed with air. Washing must be performed only in specially designed bowls or containers with a fused lid so that, if the liquid ignites, the lid closes automatically and smothers the fire. Larger washing containers (from 500 x 500 mm) must be provided with an extractor.

Generators, wiper motors, small-power motors and other electrical equipment for motor vehicles are being increasingly fitted with long-storage capacitors (e.g. for the interference suppression of receivers and transmitters).

When such parts are washed, it is possible for the capacitor to discharge when immersed in benzine, there then being the danger than inflammable liquids will be ignited. For this reason, parts with capacitors must now only be washed in tri- or perchloroethylene.



On the subject of starting motors it has already been pointed out in earlier repair manuals that after the parts have been washed, particularly after windings have been washed in benzine, they must be dried thoroughly. After sliding-gear starting motors have been washed they must first of all be operated on the test bench without the closure cap in order to prevent explosions.

Tri- and perchloroethylene are liquids whose vapours have a narcotic effect and are hazardous to health if inhaled over long periods of time. Trichloroethylene vapours are heavier than air and, therefore, the risk is greater near ground level. Protective goggles and gloves must be worn when washing.

Regular or continuous cleaning with trichloroethylene must take place only in specially designed containers with the extractor switched on. When washing, avoid leaning over the trichloroethylene container.



11. Examination and repair

General:

Examine all parts for wear and damage.

Replace worn parts. Used bolts with Loc-wel strips or Uni-Stop nuts must not be re-used!

Use only new bolts or nuts for final assembly.

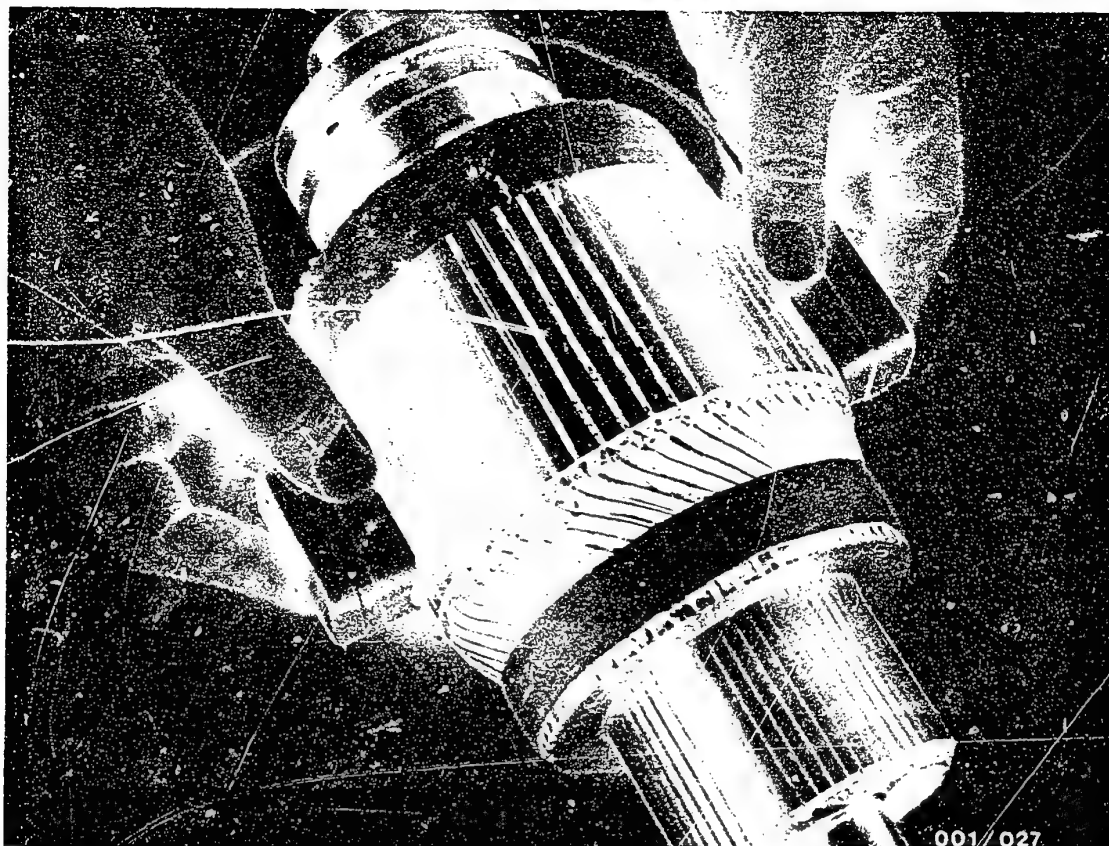
In the case of T-type starting motors 0 001 6 ..., which still had tab washers for the bolts on the intermediate bearing, use only micro-encapsulated bolts when repairing. If necessary, pin the intermediate bearing.

Replace clutch discs and round nut (wear parts)

Lubricate the starting motor before and during assembly in accordance with the lubrication table. Where necessary, lubrication points and lubricants are given in the text.

In addition, there is a complete lubrication table appended to the end of this manual.





Test armature

Test armature for interturn short circuit using tester 0 681 169.. (see picture).

Test for short circuit to ground using high-tension tester 0 681 103 400/..402 (no picture).

Test voltage: 80 V a.c. (max. 125 V a.c.)

Test duration max. 2 seconds.

Look for good soldered joints between armature winding and soldering lugs of commutator.

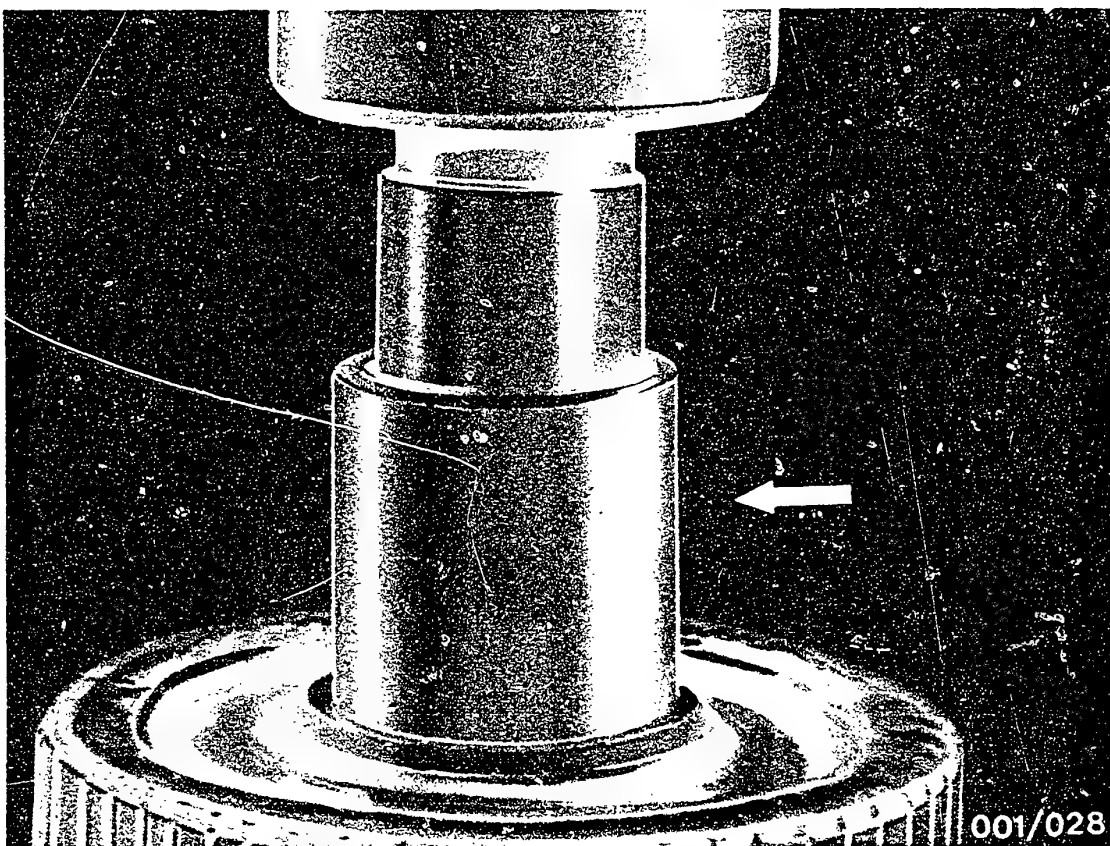
Check condition of winding bandages.

C5

Examination and repair

T-Type starting motors 0 001 6.., 24 V



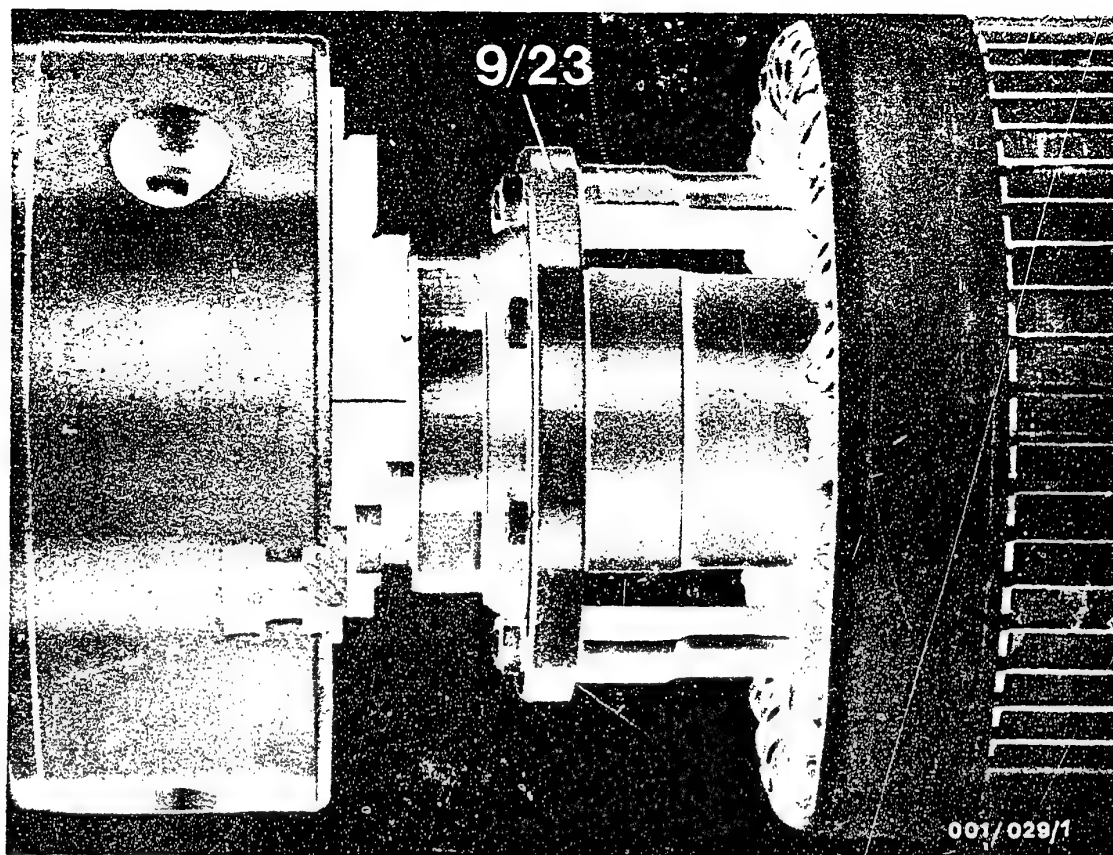


Replace bushing

If damaged, replace bushing (9/20) - Compo bushing - (arrow) in the commutator.

Necessary tools: Spring collet KDAW 9995
Press-in mandrel EFAL 64 (in picture)
Finishing tool EFAL 63
Press in bushing as far as it will go using arbor press.





Skim commutator

Minimum diameter 77 mm on all T-Type starting motors
0 001 6..

If the armature has to be removed, always skim the commutator.

To do this, re-fit intermediate bearing (9/23).

Clamp the intermediate bearing by the inside with the jaw chuck of the lathe - not on the outside by the seat of the ball bearing (see picture).

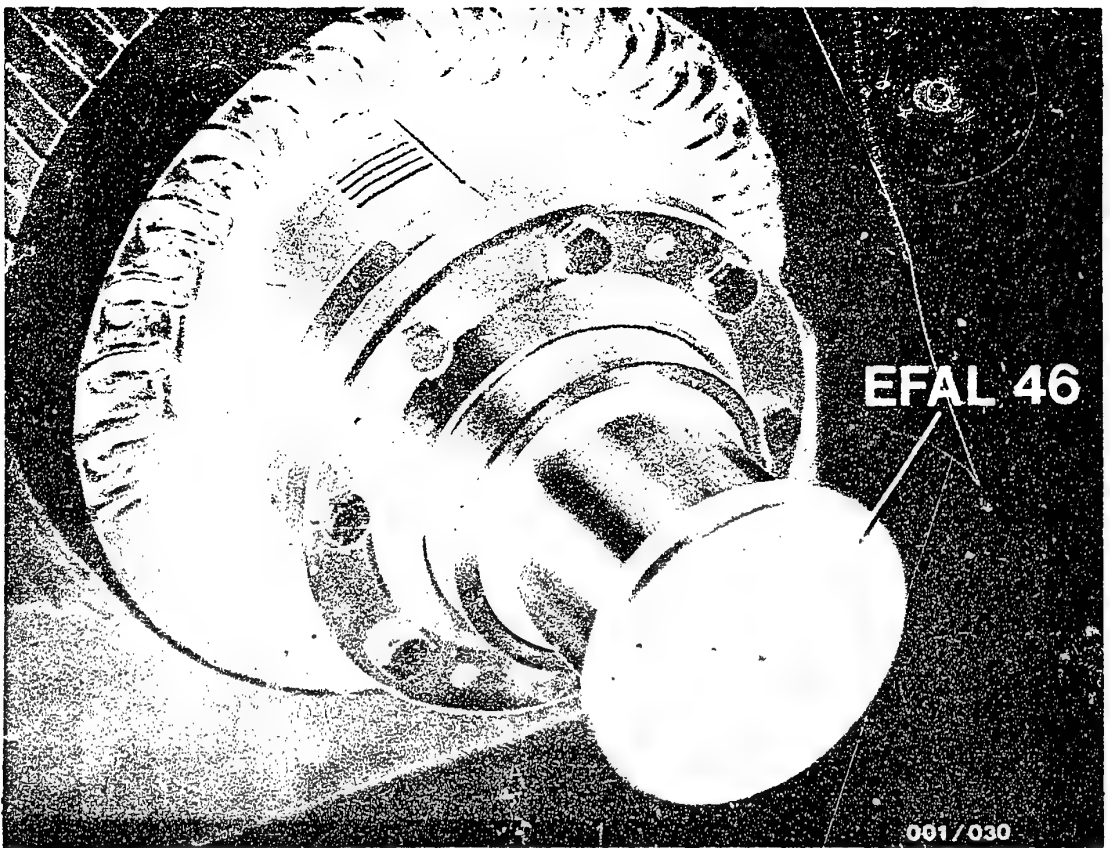
Clamp commutator end of armature with live centre in tailstock.

Rough-turning:

We recommend the use of a carbide cutting tool.

Skim the commutator until score marks or burn marks are no longer visible.

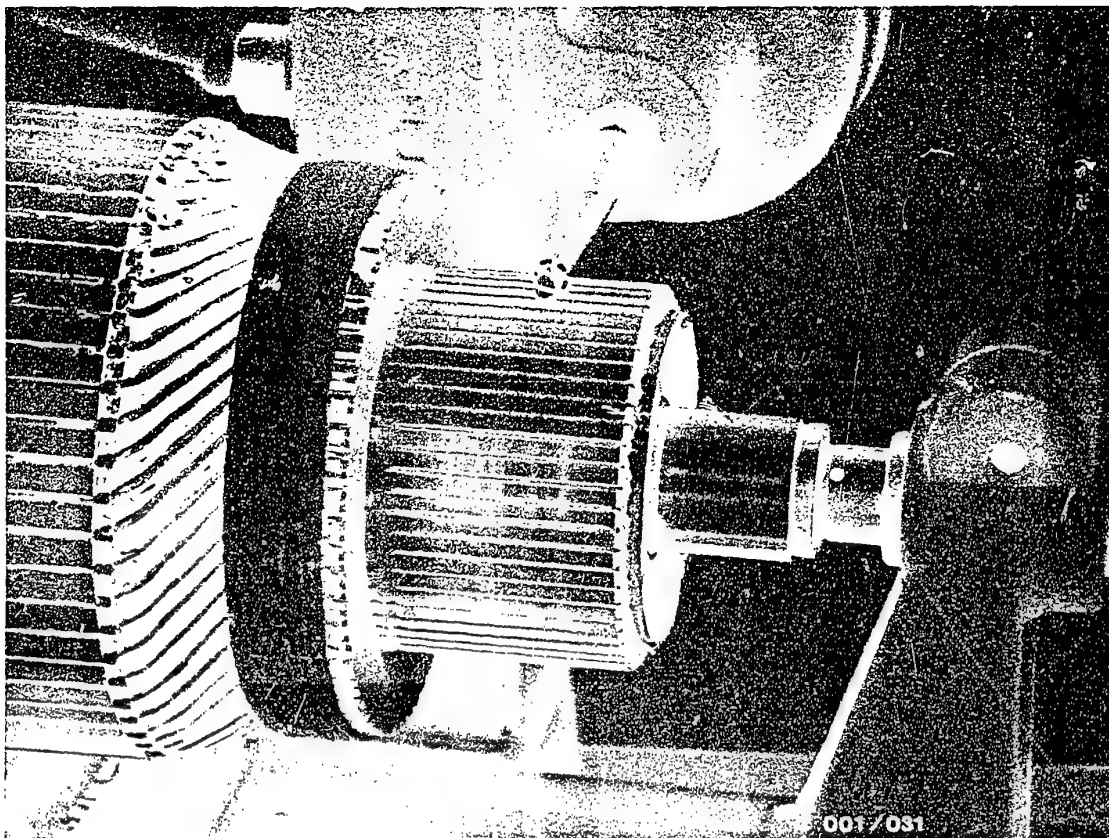




Undercut commutator (preparations)

Insert thrust member EFAL 46 (picture) and clamp armature in holding centres of undercutting saw KDAW 9998.





Undercut commutator and finish-turn

Undercut insulation between the laminations 0.8 mm deep using undercutting saw KDAW 9998.

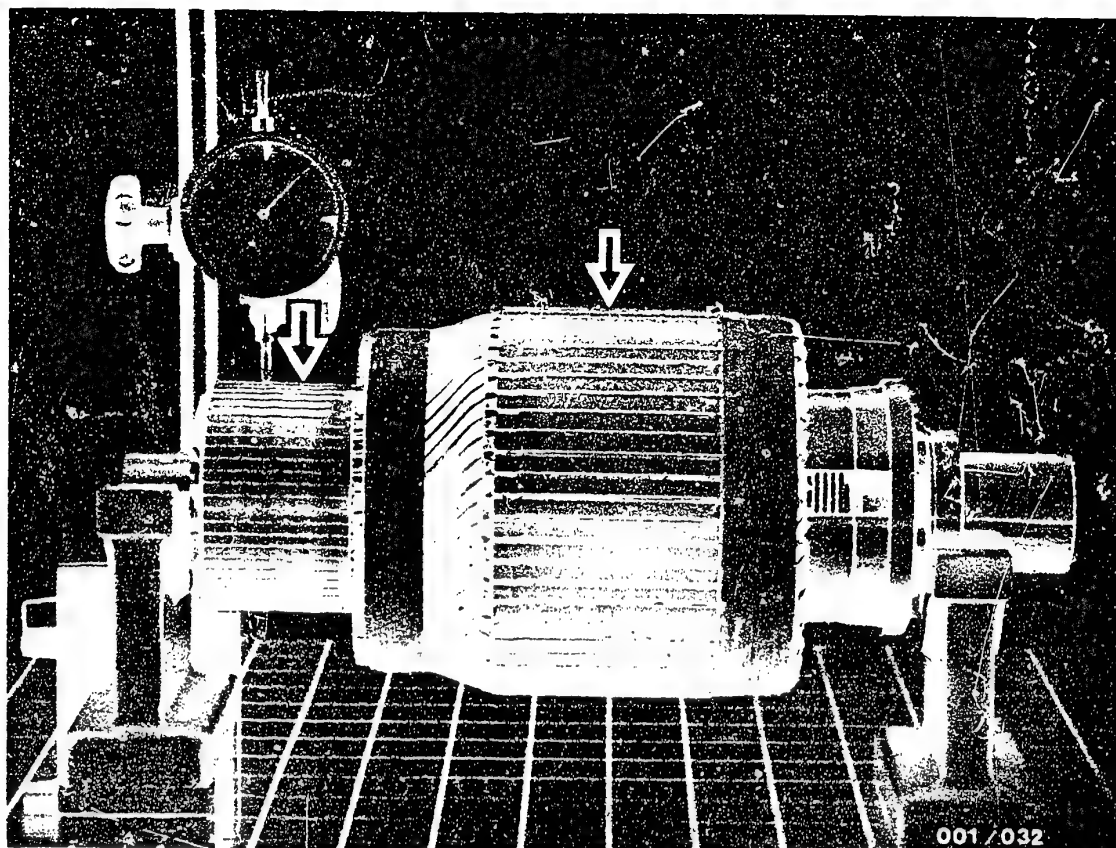
Finish-turning:

Clamp commutator in lathe again and skim with fine turning tool.

Turning chips may be max. 0.03 mm thick.

After finish-turning, brush out the commutator with a clean thread-cleaning brush free from oil and grease.





Test true running of the complete armature:

Commutator ≤ 0.03 mm (arrow)

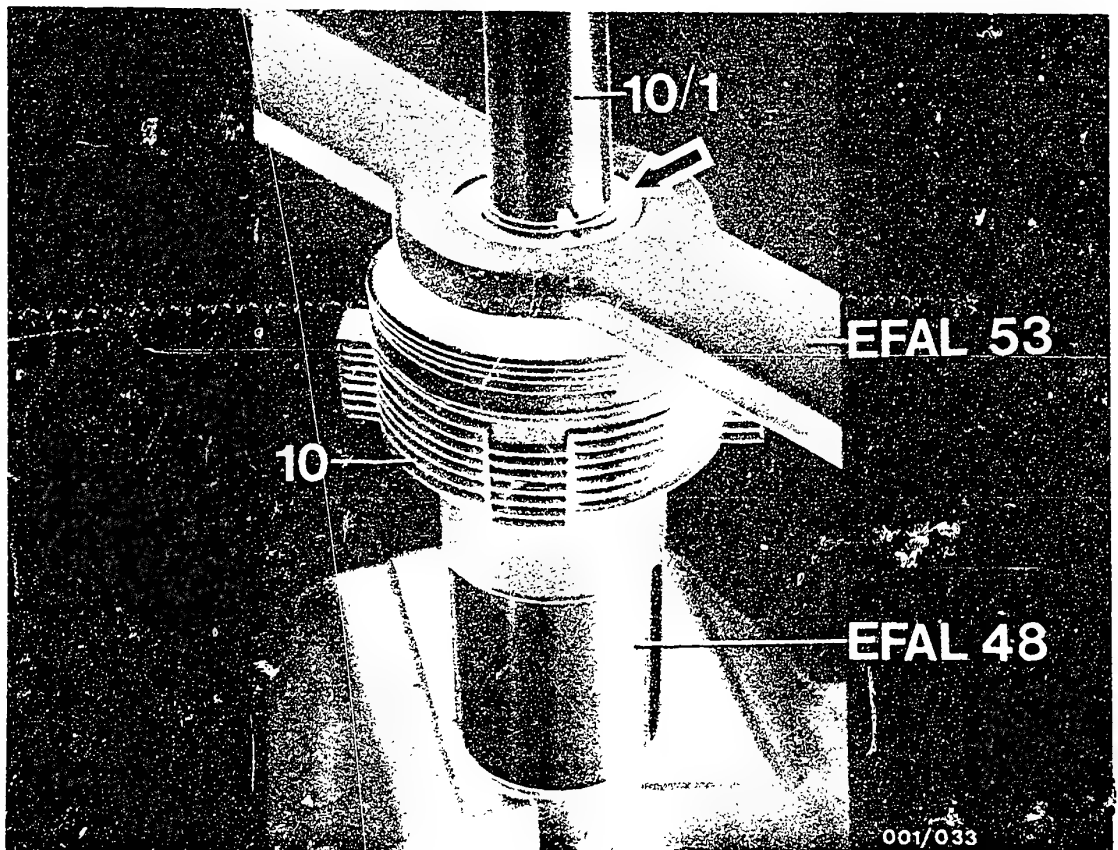
Laminated core ≤ 0.1 mm (arrow)

C10

Examination and repair

T-Type starting motors 0 001 6.., 24 V





Dismantle multi-disc clutch:

Clamp complete multi-disc clutch (10) in lathe and turn down round nut (10/10) at the caulked section (arrow) (round nut is not hardened at this point).
When turning down, do not damage thread of armature shaft (10/1).

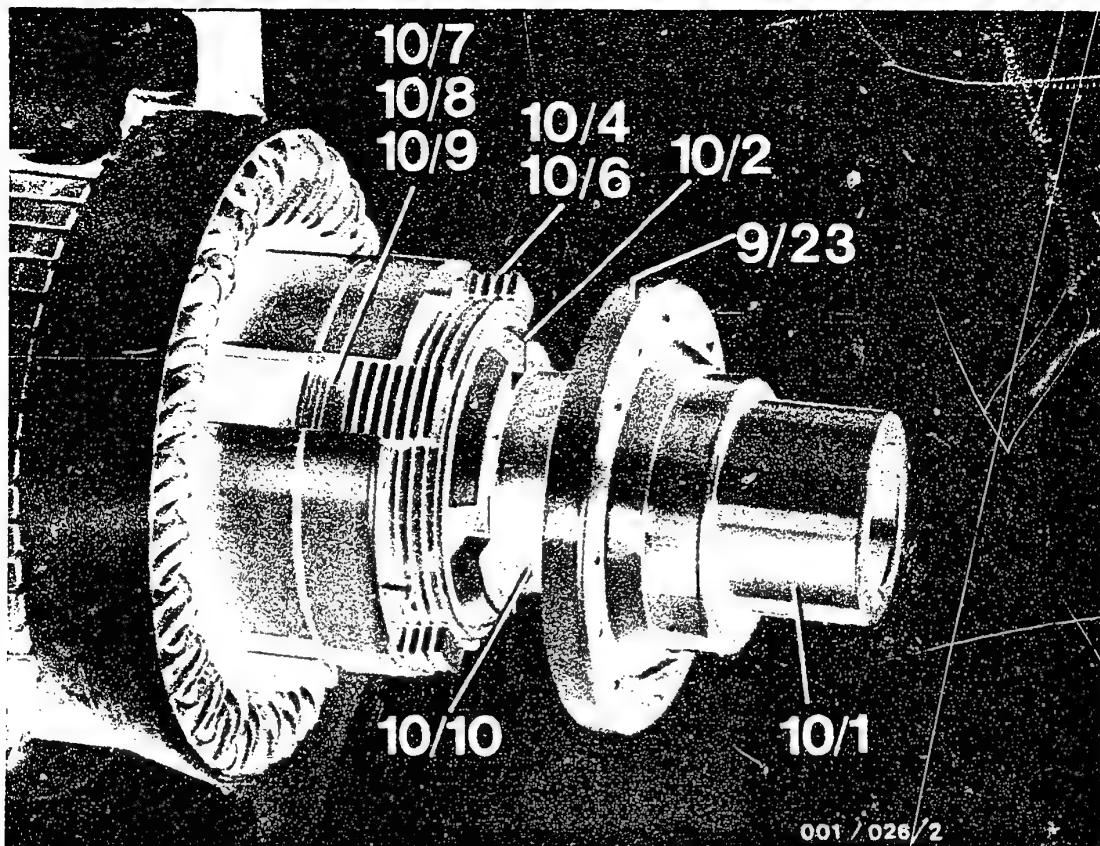
Clamp clamping bolt EFAL 48 in vice and mount multi-disc clutch (10).

Loosen round nut (10/10) using wrench EFAL 53.

Note whether right-hand or left-hand thread.

Examine parts (visual inspection, sounding test) and replace if necessary.

Always replace clutch discs and round nut (wear parts).



Assemble multi-disc clutch:

Lightly grease all clutch parts with silicone grease 5700082025 (Ft2V3).

Assemble - in the correct order - armature shaft (10/1), clutch part (10/2), clutch discs (10/4) and (10/6), shims (10/7), V-ring (10/8) and spring washer (10/9).

Screw on round nut (10/10) - do not yet caulk.

Introduce assembled multi-disc clutch into armature and provisionally fasten intermediate bearing (9/23) to drive housing of armature using the old screws.



Slipping torque (overload protection):

Does not occur in normal operation.

If the ignition or start of injection is incorrect and the engine is started, there may be a backfire as a result of which the engine briefly turns in the opposite direction to the starting motor.

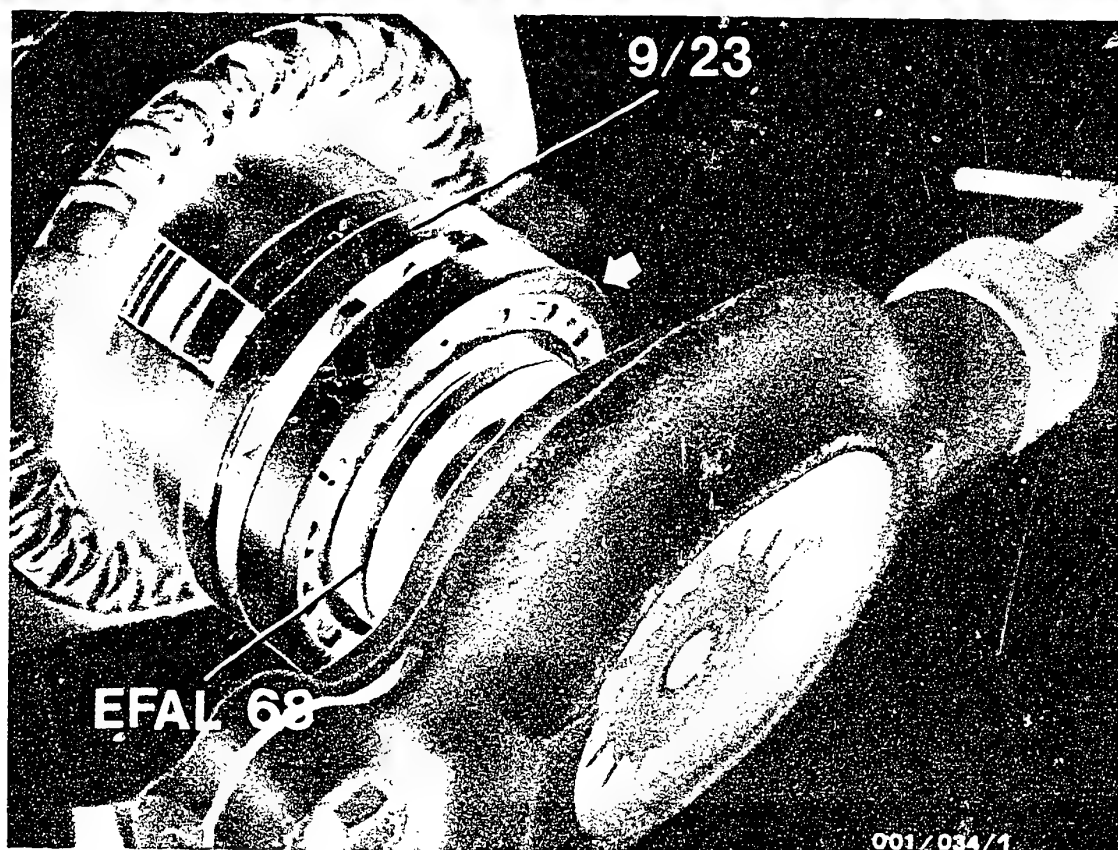
The multi-disc clutch must, in this case, slip.

If the slipping torque is too low, the multi-disc clutch slips before the starting motor can deliver its maximum torque.

If the slipping torque is too high, the starting-motor pinion and possibly the armature shaft can be damaged.

The slipping torque is measured using the torquemeter KDAL 5476. To do this, the armature must be removed and clamped in the clamping support.





Set slipping torque (against direction of rotation):

Insert bearing sleeve EFAL 68 over armature shaft in intermediate bearing (9/23). This prevents one-sided loading during testing.

Response torque of slipping torque:

Starting motor 0 001 600 ...	
601 ...	} 300 - 420 Nm
602 ...	
603 ...	
Starting motor 0 001 608 ...	} 320 - 420 Nm
611 ...	
Starting motor 0 001 613 001	420 - 500 Nm

Set by adding or removing shims. The ball bearing (arrow) in front of the intermediate bearing (9/23) need not be mounted for this test.



Note:

Do not use shims thinner than 0.35 mm.

If the total thickness of the shims exceeds 1.2 mm, a new clutch disc (steel disc) must be fitted instead of the shims.

Overrunning torque:

Torque exerted on the starting-motor armature by the engine after it has started.

The starting-motor pinion is turned faster than the armature.

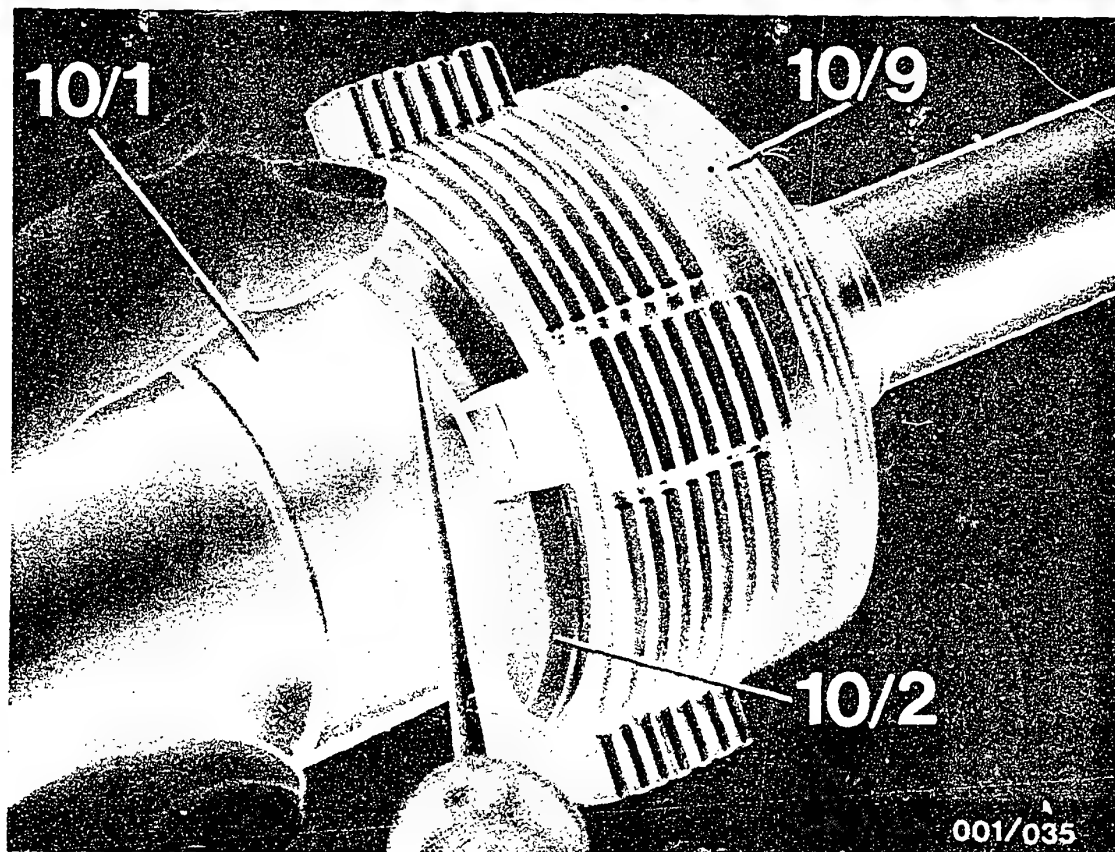
If the overrunning torque is too low, the multi-disc clutch will not lock and provide positive mechanical connection.

If the overrunning torque is too high, the starting-motor armature is driven by the engine as it rotates and is accelerated to impermissibly high speeds. The armature is destroyed as a result.

Test the overrunning torque using bearing sleeve EFAL 68 and torquemeter EFAL 54 (not shown). Test in the direction of rotation of the armature

Overrunning torque	Starting motor	
	0 001 600 ...	
	601 ...	0.6 - 1.0 Nm
	602 ...	
	603 ...	
	Starting motor	
	0 001 608 001	0.8 - 1.8 Nm
	002	
	.	
	·	0.6 - 1.0 Nm
	·	
	.	
	008	





Test axial play of drive spindle

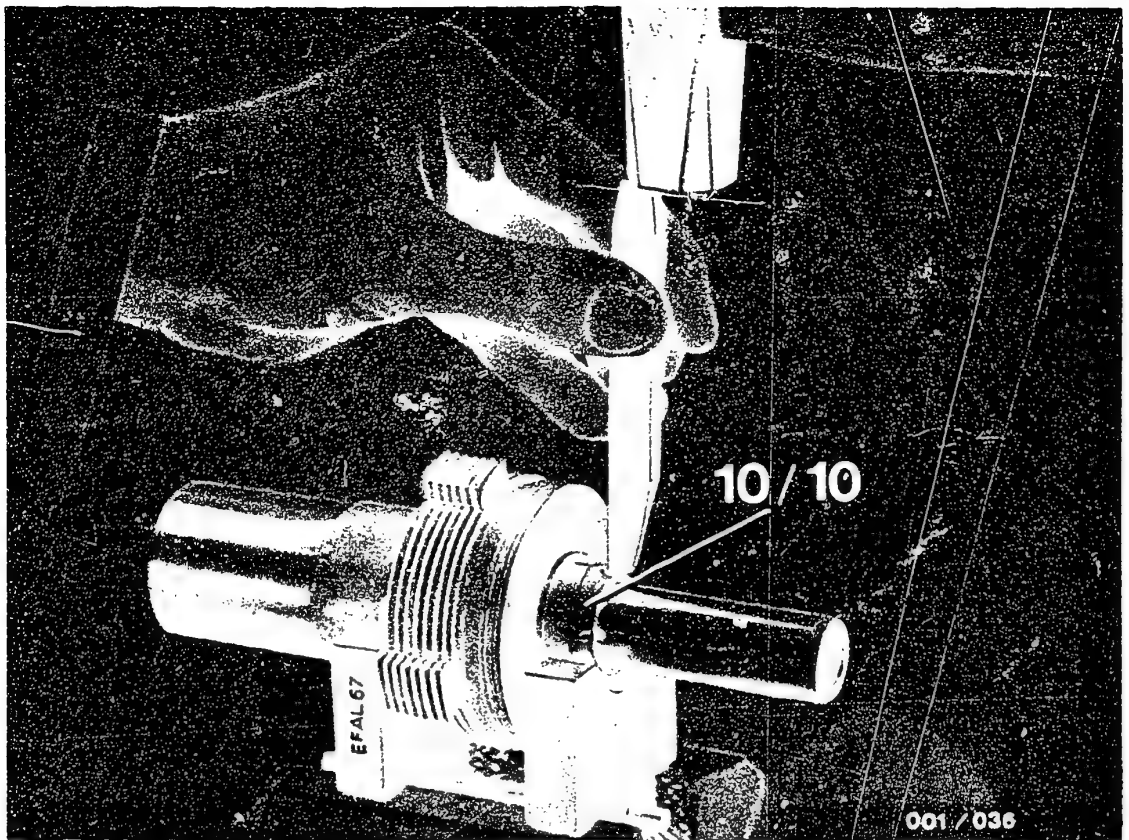
Between pressure sleeve (10/2) and shoulder of armature shaft (10/1) there must be a play of 0.5-1.3 mm when the clutch is lightly pressed together by hand.

Spring washer (10/9) must not be compressed.

Screw off intermediate bearing and screw down again with new micro-encapsulated bolts.

Tightening torque: 7-8 Nm.





Caulk round nut:

Take down complete multi-disc clutch and tighten round nut (10/10) (100 Nm). To do this, use clamping bolt EFAL 48 and wrench EFAL 53.

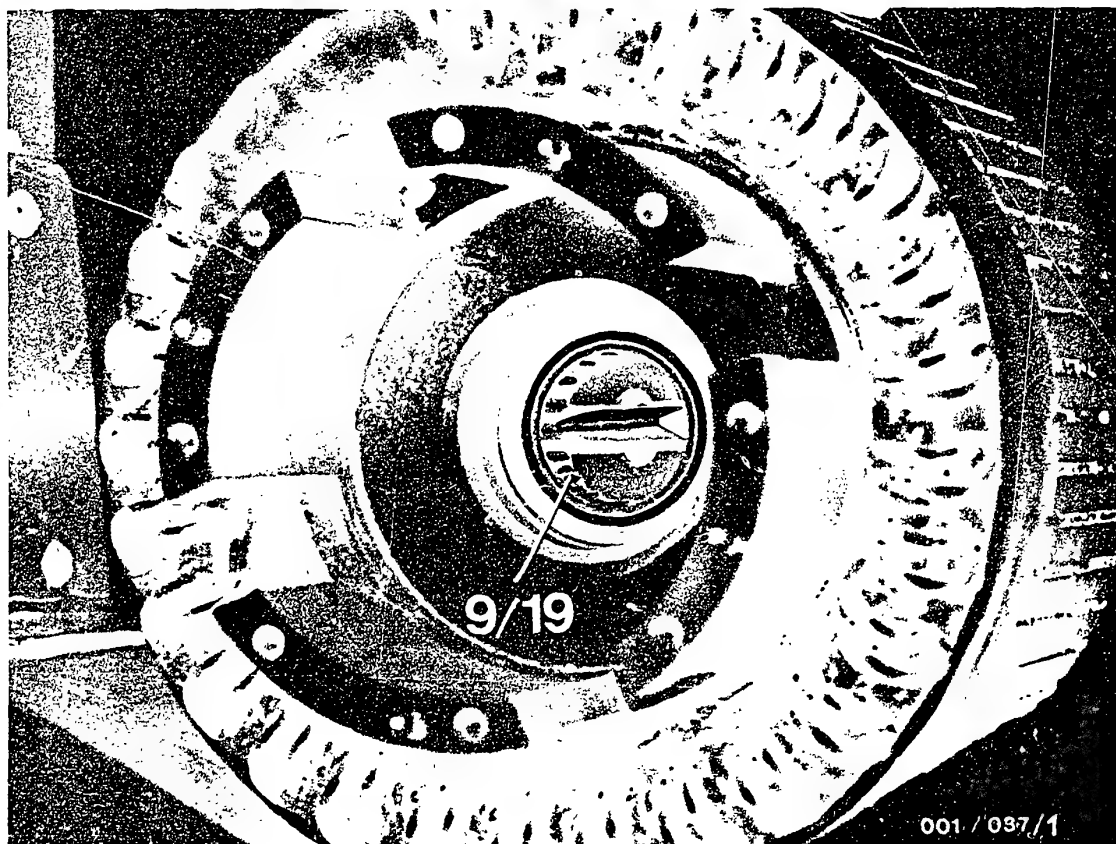
Clamp support EFAL 67 in vice and mount complete multi-disc clutch in position.

Carefully caulk round nut with caulking tool - do not cut the metal.

Note:

The round nut (10/10) is hardened. Only the collar (which is caulked) is not hardened.





Replace needle-roller bearing

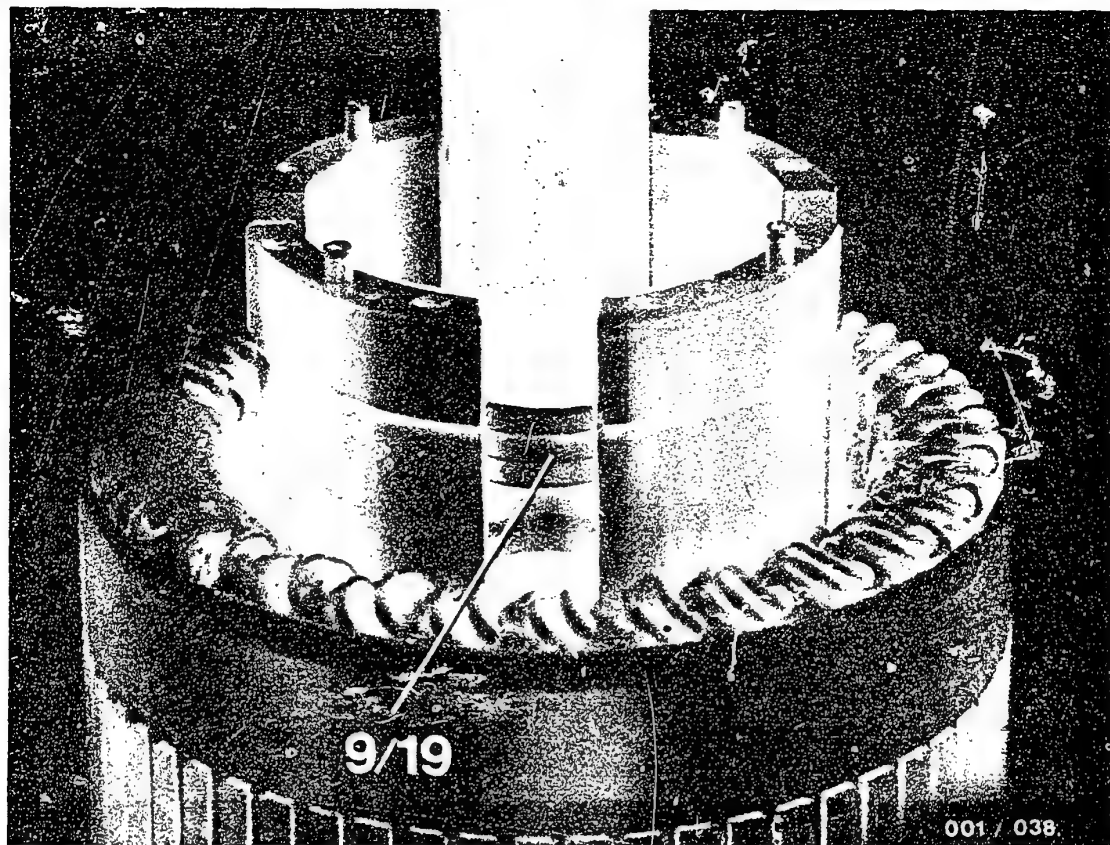
The needle-roller bearing (9/19) need only be replaced if the visual inspection has revealed that it is rusty or damaged.

Removal: Force out retainer using suitable screwdriver (the retainer has already been removed in the picture). Place 2 half-shells of press-out tool behind the needle-roller bearing (9/19).

Place the expansion chisel of the press-out tool between the two half-shells from the commutator end (the half-shells are thus spread apart).

Needle-roller bearing (9/19) can be forced out.





Fit needle-roller bearing

Grease new needle-roller bearing (9/19) with special lubricating grease 5932240150 (VS 10832 Ft) and slip onto press-in mandrel.

Press in needle-roller bearing vertically as far as it will go. Fit new retainer.

Armature shaft (Engagement shaft)

Up to FD 821 (Jan.78) the engagement shafts were supplied with a locking washer, a groove in the threaded part and a pinion-fastening nut (Uni-Stop nut). When repairing starting motors with this engagement shaft, use a new locking washer 1 000 146 001 and Uni-Stop nut 2 003 315 002 (M 10 x 1.5) or 2 003 315 000 (M 10 x 1) depending on the type of thread.

As of FD 822 (Feb.78) the following changes were made: No groove in threaded part. Instead there is a 3 mm wide groove behind the threaded part for a parallel key to stop the shaft turning against the pinion. There is a corresponding groove in the pinion bore.

The engagement shaft has an M 10 x 1.5 thread.

The pinion is now fastened only with Uni-Stop nut
2 003 315 002.

The meshing-damping spring has been moved from outside to inside the guide sleeve.

If a replacement is necessary, it is now only possible to obtain the new engagement shaft complete as a parts set with Uni-Stop nut 2 003 315 002 and parallel key 1 902 300 021.

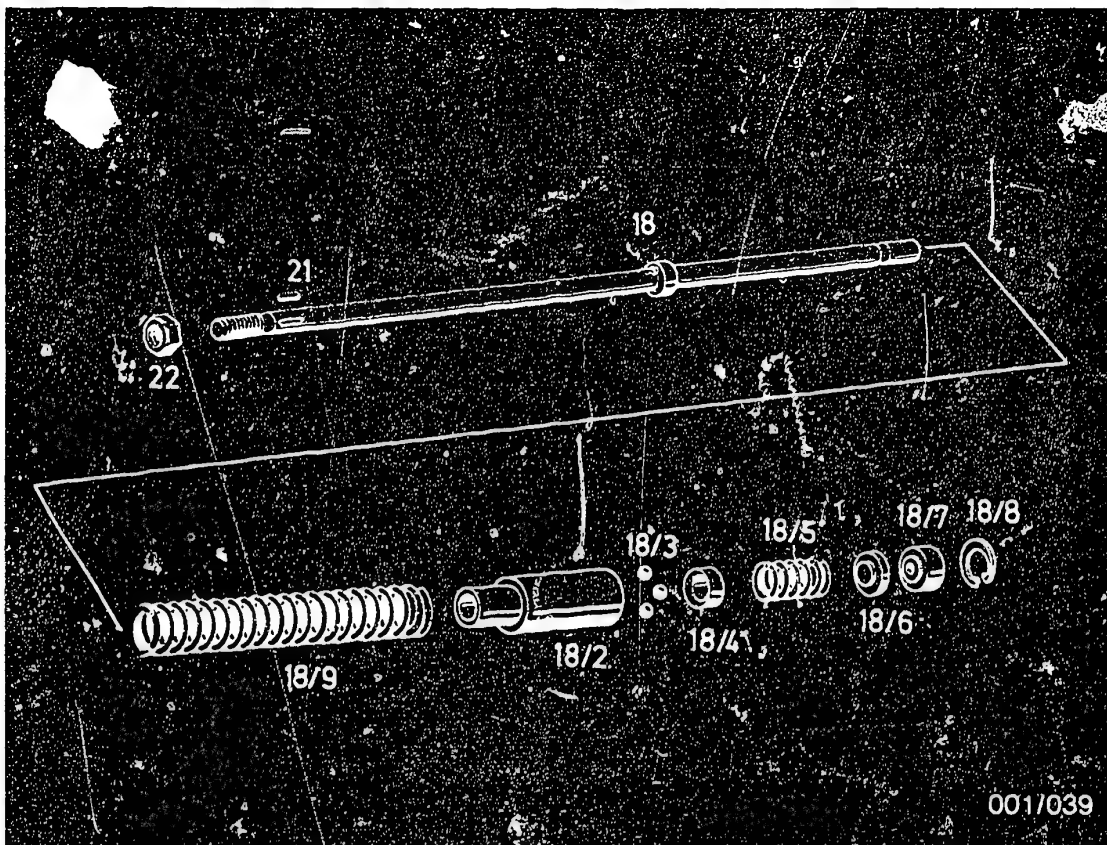


Comparison of old and new engagement-shaft parts sets.

Engagement-shaft parts set old	Engagement-shaft parts set new
2 003 050 001	1 007 010 010
003	011
006	013
019	Temporarily discontinued
021	015
023	016
1 003 050 008	012

Important: To repair an old starting motor with a new engagement shaft (change as of FD 822) it is also necessary to use a new pinion. Conversely, new pinions (with a groove in the bore) can also be used for the old engagement shafts (with locking washer). Whenever repairs are carried out, always use a new Uni-Stop nut and tighten to a torque of 35...45 Nm (3.5...4.5 mkgf).





0017039

Dismantle armature shaft (engagement shaft)

Remove compression spring (18/9) from armature shaft (18) in direction of thread. Clamp armature shaft vertically in vice between protective jaws. Take off retainer (18/8). Move guide bushing (18/2) and take off deep-groove ball bearing (18/7), control plate (18/6), compression spring (18/5), control plate (18/4) and balls (18/3). Check all parts for proper condition. Replace if defective.

Before assembling, grease all parts thoroughly with special lubricating grease 5 932 240 150 (VS 10832 Ft). Balls (18/3) are held by the grease.

Note order of parts.

Retainer (18/8) must lock in position properly.

Return spring for starting-motor pinion and starting-motor solenoid:

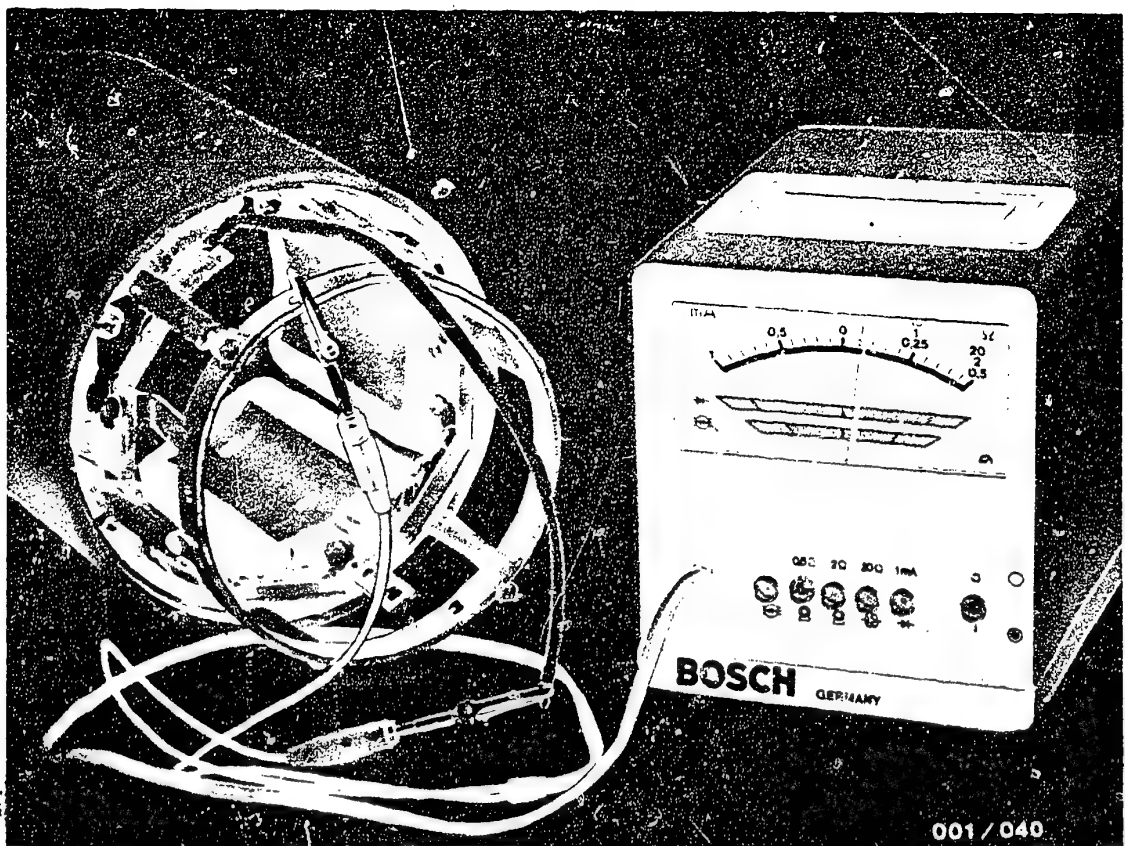
Starting pressure

70 - 90 N

End pressure

110 - 130 N





Test windings electrically

Test brake winding

(with Bosch tester WPG 012.00 or commercially available resistance bridge or commercially available ohmmeter).

10 kW starting motor

0 001 500 .., .. 611 .. = $0.053 \text{ ohm} \pm 10\%$

15 kW starting motor

0 001 601 .., .. 508 .. = $0.072 \text{ ohm} \pm 10\%$

Ground-short-circuit test using tester

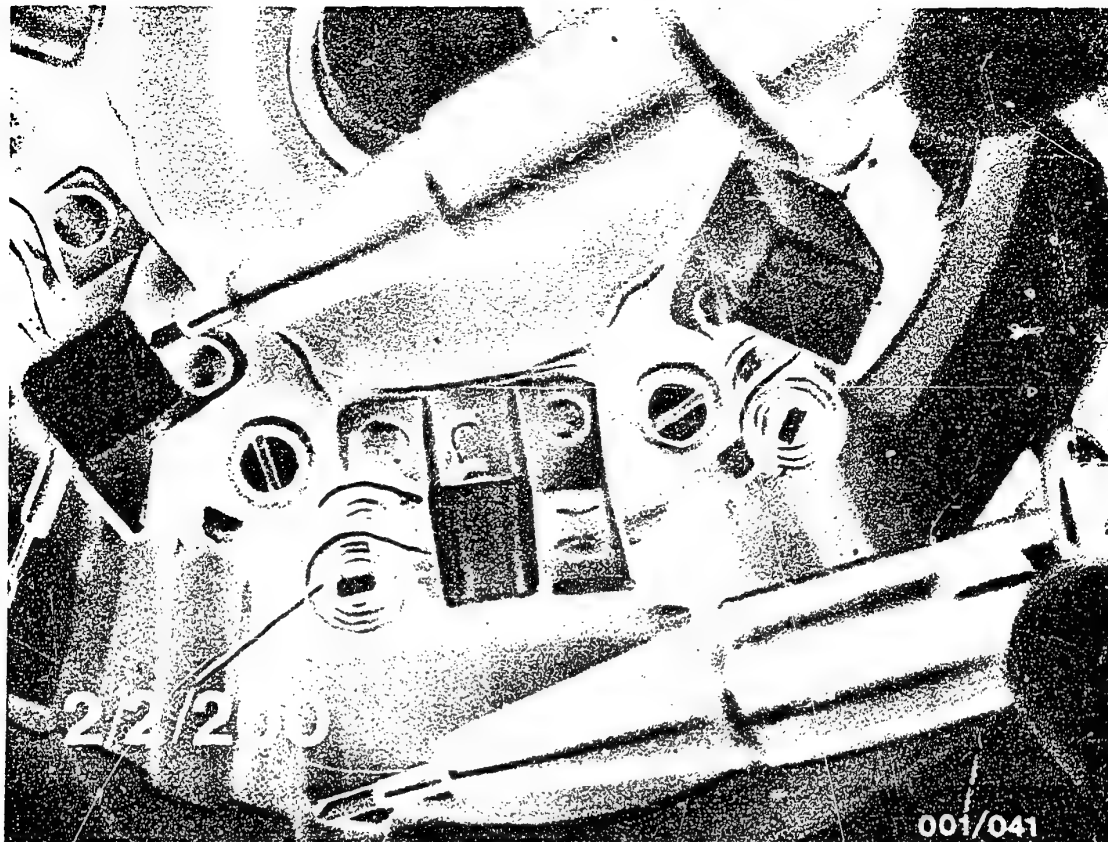
0 681 103 400/.. 402

Test voltage 80 V a.c.

Test excitation winding for open circuit.

Test voltage 6 V a.c.





Test commutator end shield

Test insulated brush holders for short circuit to ground using tester 0 681 103 400/..402.

Test voltage 80 V a.c.

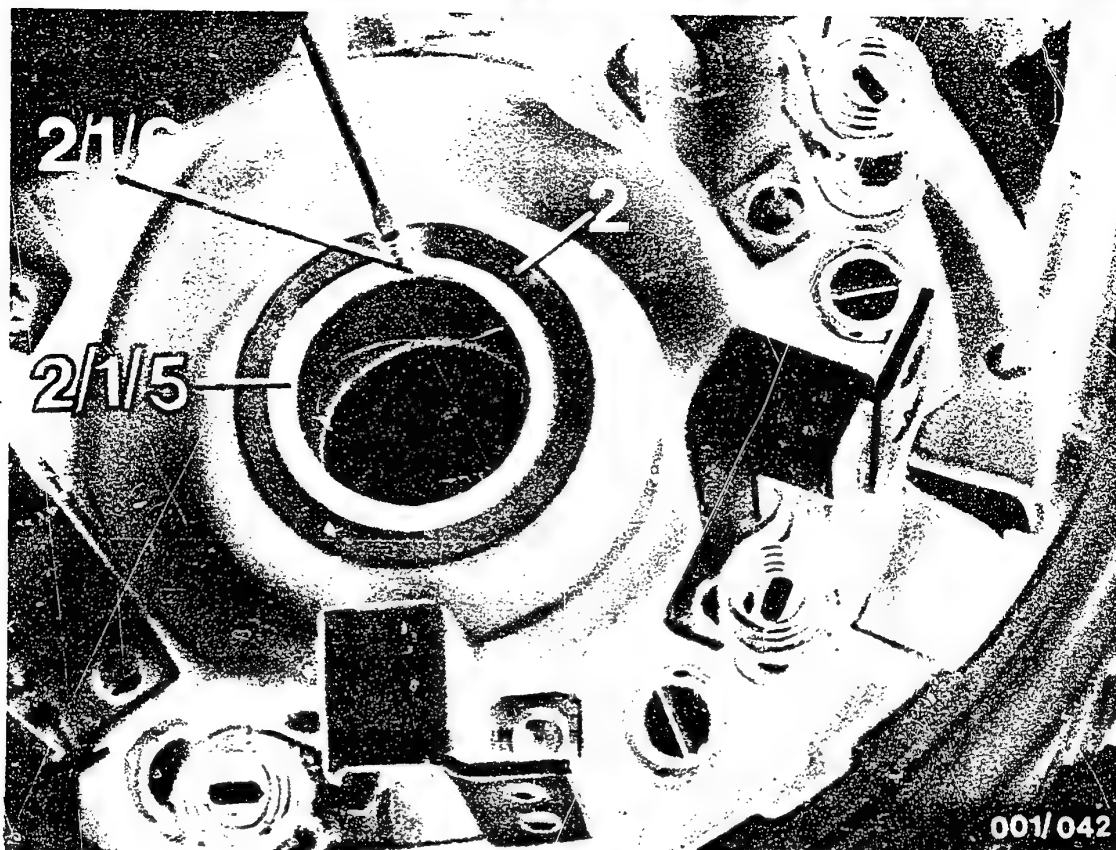
Check spiral springs (2/2/200) for carbon brushes.

Replace spiral springs if damaged or burnt out.

Test brush pressure using spring scale KDAL 9993:

13-16 N per spring





Replace bushing:

Screw out headless setscrew (2/1/6) and force out bushing (2/1/5) using press-out mandrel EFAL 52. Press in new bushing using press-in mandrel EFAL 51. Do not jam lubricating felt.

Bushing (2/1/5) must be flush with commutator end shield (2) on the inside.

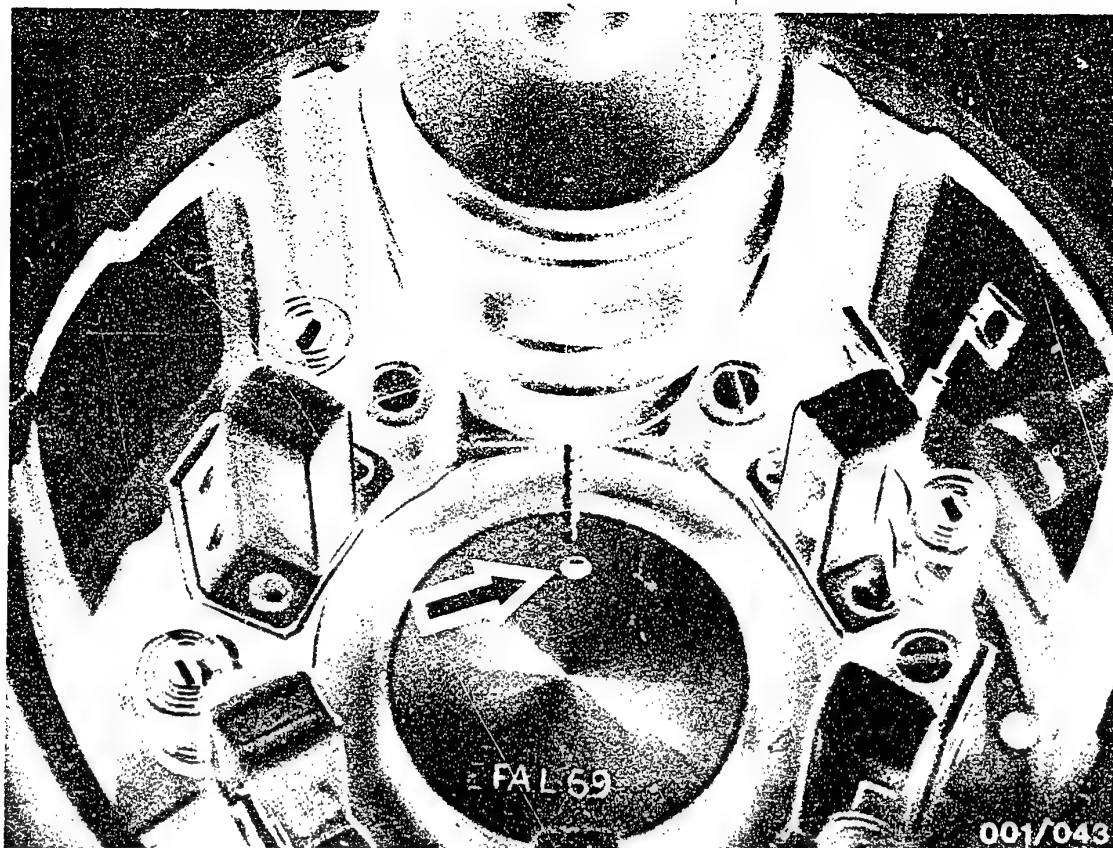
Re-lubricate lubricating felt with oil 5 962 260 605 (VS 13834 oil) via oil hole.

D1

Examination and repair

T-Type starting motors 0 001 6.., 24 V





Fit headless setscrews in commutator end shield

Using drilling jig EFAL 69, drill hole 3.2 mm \varnothing (arrow) and tap M 4 thread.

Screw in headless setscrew.

Setscrew must not project.

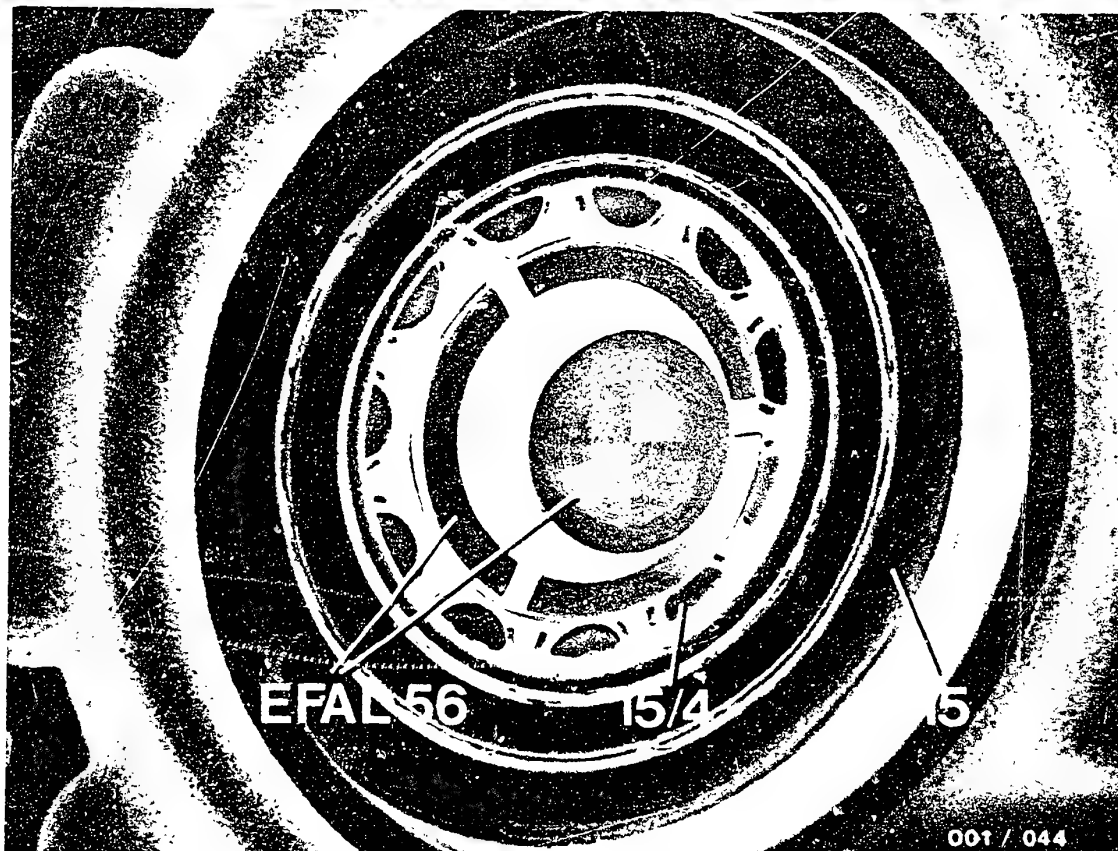
Caulk slot of headless setscrew after screwing in.

D2

Examination and repair

T-Type starting motors 0 001 6..., 24 V





Replace cylindrical-roller bearing in drive-end-bearing housing

TB starting motors 0 001 600 ..., .. 601 ..

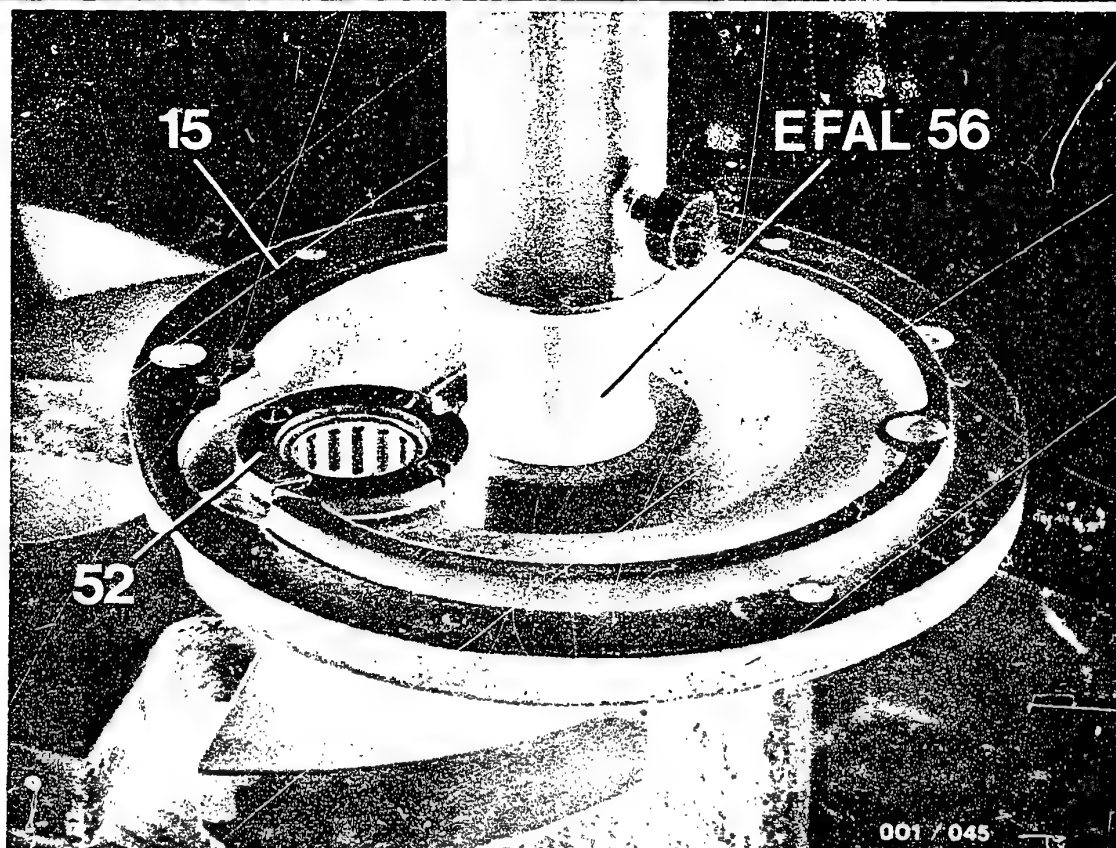
If damaged, replace cylindrical-roller bearing (15/4) with supporting plate and radial-lip-type oil seal in drive-end-bearing housing (15).

Force out cylindrical-roller bearing (15/4) with tool EFAL 56.

The edges of the 3 jaws of tool EFAL 56 must lock in between radial-lip-type oil seal and cylindrical-roller bearing (15/4).

Radial-lip-type oil seal must be replaced. Do not forget supporting plate. Before fitting, grease cylindrical-roller bearing and supporting plate with special lubricating grease 5 932 240 150 (VS 10832 Ft).

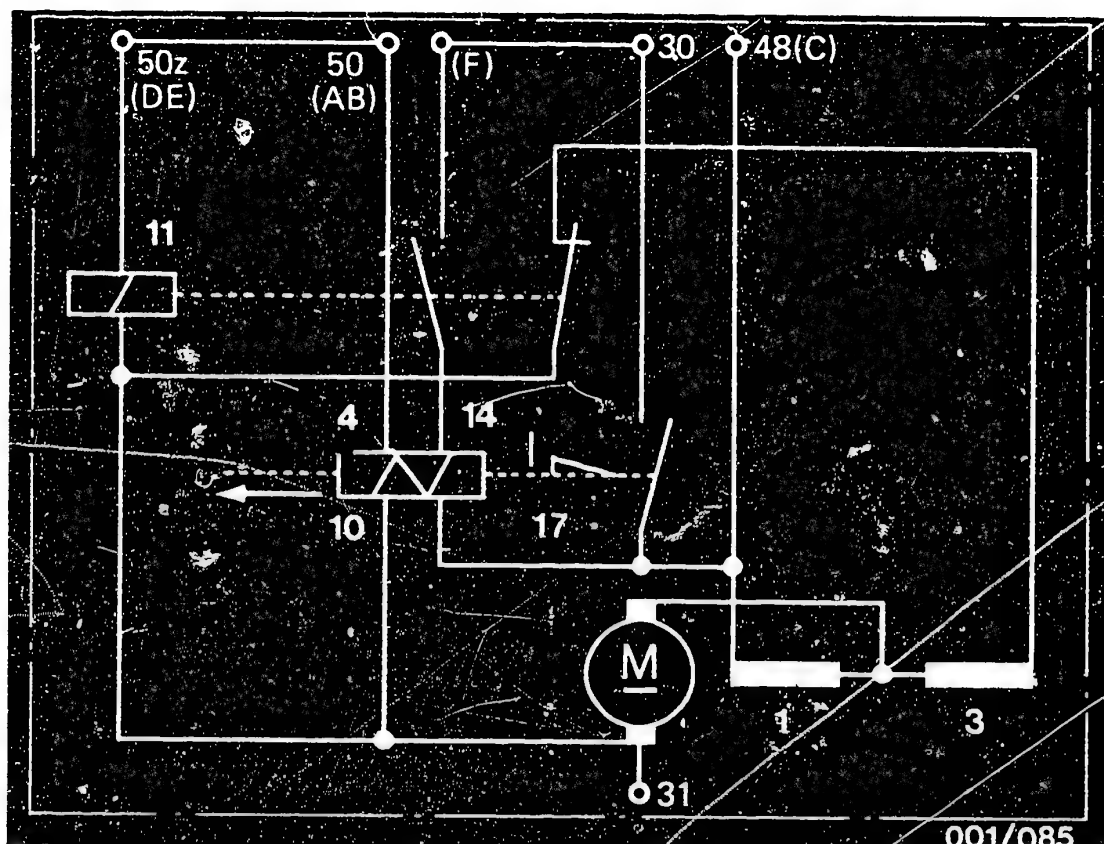




Replace cylindrical-roller bearing (TF starting motors 0 001 608 ..., .. 611 ..., .. 613 ...) in inner drive-end-bearing housing (15).

Force out cylindrical-roller bearing with tool EFAL 56. The edges of the 3 jaws of tool EFAL 56 must lock in between radial-lip-type oil seal and cylindrical-roller bearing. Radial-lip-type oil seal must be replaced. Do not forget supporting plate. Before fitting, grease cylindrical-roller bearing and supporting plate with special lubricating grease 5 932 240 150 (VS 10832 Ft).

Screw off bearing end plate (52) for cylindrical-roller bearing and pull cylindrical-roller bearing out of bearing end plate using puller tool KDAW 9995. Before fitting, grease new cylindrical-roller bearing with special lubricating grease 5 932 240 150 (VS 10832 Ft).



001/085

- | | | | |
|---|-----------------|----|------------------------------|
| 1 | Series winding | 10 | Solenoid switch |
| 3 | Brake winding | 11 | Control relay |
| 4 | Holding winding | 14 | Pull-in and opposing winding |
| | | 17 | Detent pawl |

Test solenoid switch electrically (coil resistance)
TF starting motor 0 001 613 001

Test points on pull-in winding 14
 black and yellow leads
 (large cross section).

Test points on opposing winding 14
 black and yellow leads
 (small cross section).

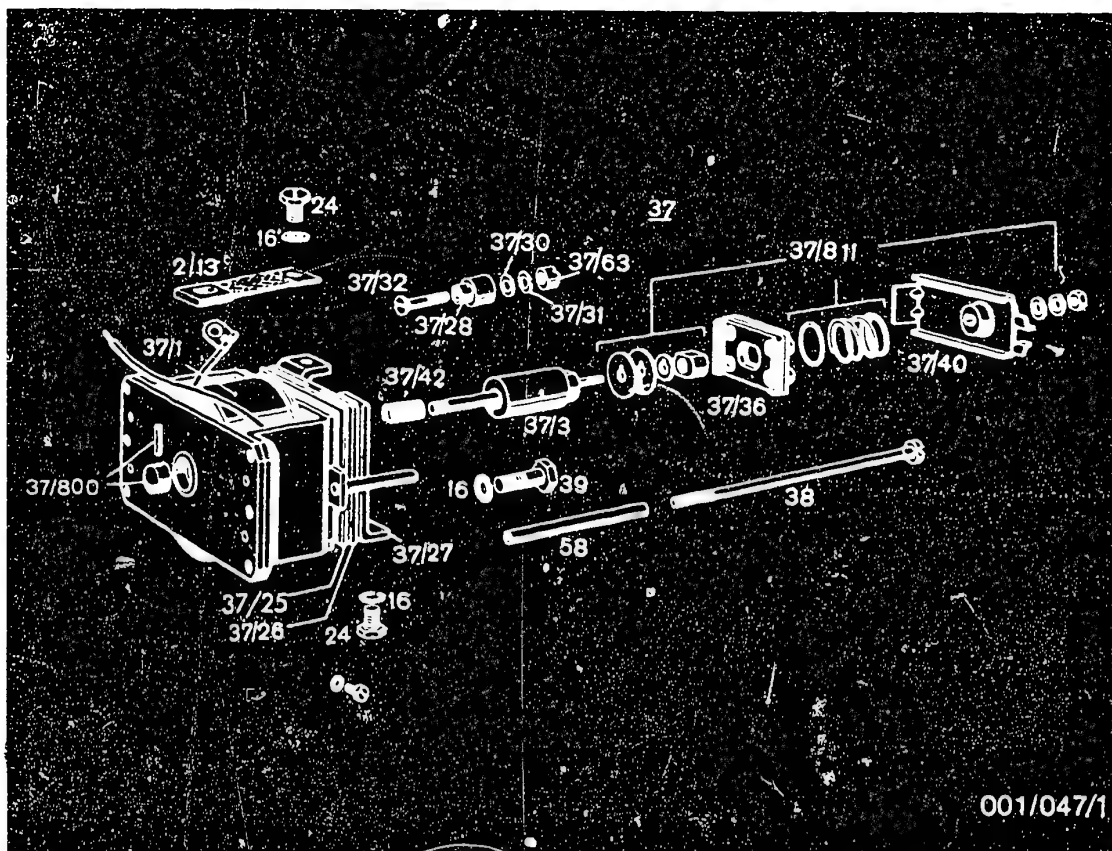
Test points on holding winding 4
 blue and red leads.



Test coil resistances - test specifications

Solenoid switch 0 331 500 ..	Opposing winding Ω	Pull-in winding Ω	Holding winding Ω
.. 001	0.63	0.16	1.8
.. 002	0.58	0.11	1.8
.. 003	0.27	0.11	1.5
.. 009	0.515	0.11	1.5
.. 011	0.515	0.11	1.5
.. 012	0.27	0.11	1.5
.. 023	0.27	0.11	1.5
.. 024	0.27	0.11	1.5
.. 028	0.515	0.11	1.5
.. 033	0.27	0.11	1.6





001/047/1

Test solenoid switch mechanically

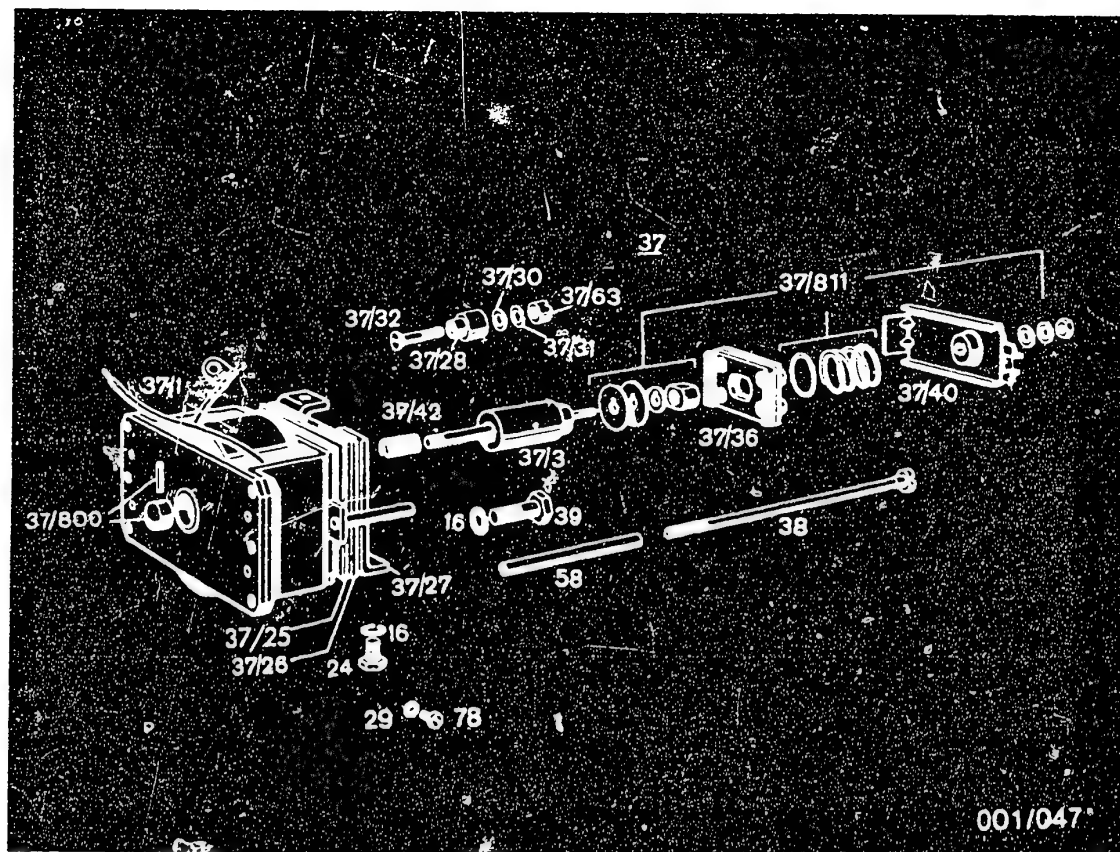
Subject solenoid switch (37) to a visual examination. Replace parts if damaged or worn. Check the proper condition of the contacts and check the bridging contact member for security. Replace burned-out or damaged windings complete with base plate.

D7

Examination and repair

T-type starting motor 0 001 6 ... 24 V





001/047

Dismantle solenoid switch:

Knock out straight pin (37/800) in the pressure cap while placing pressure cap on a support.
 Screw off pressure cap and withdraw magnetic core (37/3).
 Remove base plate with solenoid winding (37/1) from the complete contact support (insert screwdriver as a lever between base plate and contact support).
 Clean the magnetic core, bushing in the solenoid winding and spring.
 Replace angular contact supports (37/27) if burned.
 Subject insulating plates (37/26) to visual examination and replace if necessary.

In vibration-proof starting motors the base plate and bracket are bonded with two-component cement and cannot be taken apart.

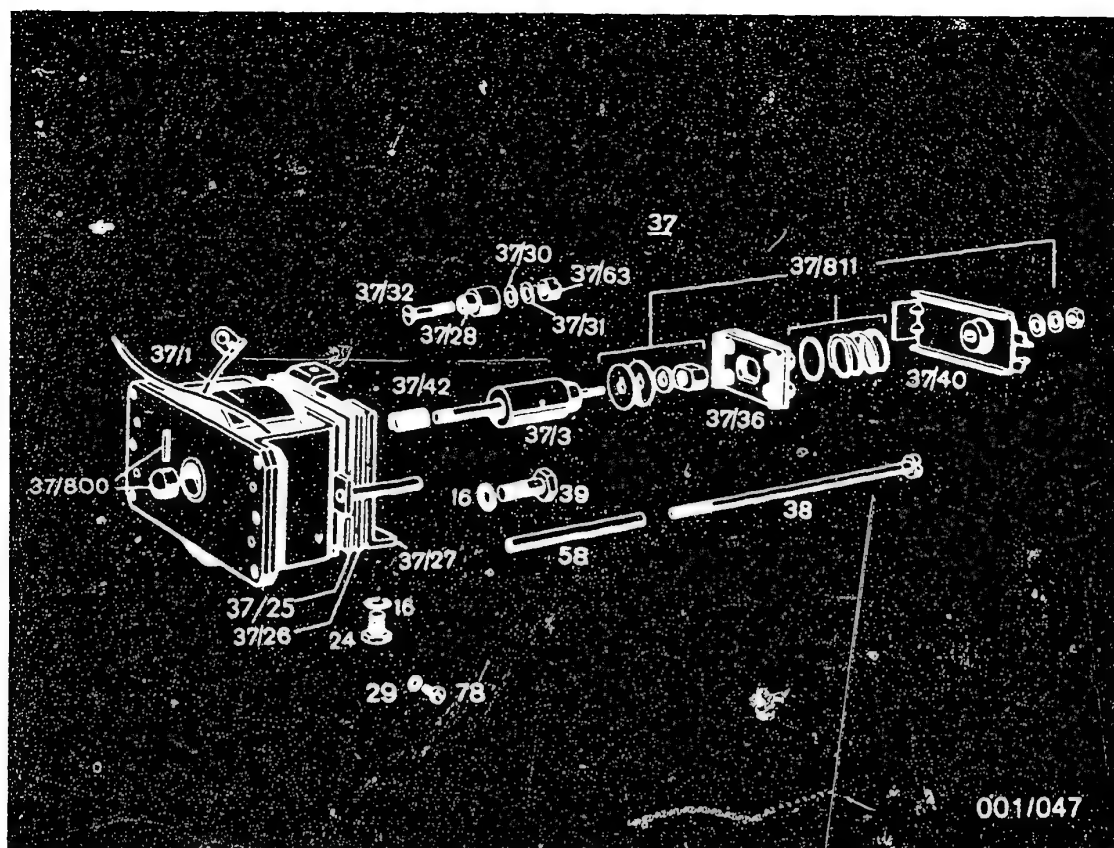
In this case replace the complete solenoid switch.

D8

Examination and repair

T-type starting motor 0 001 5 ..., 24 V





Assemble solenoid switch:

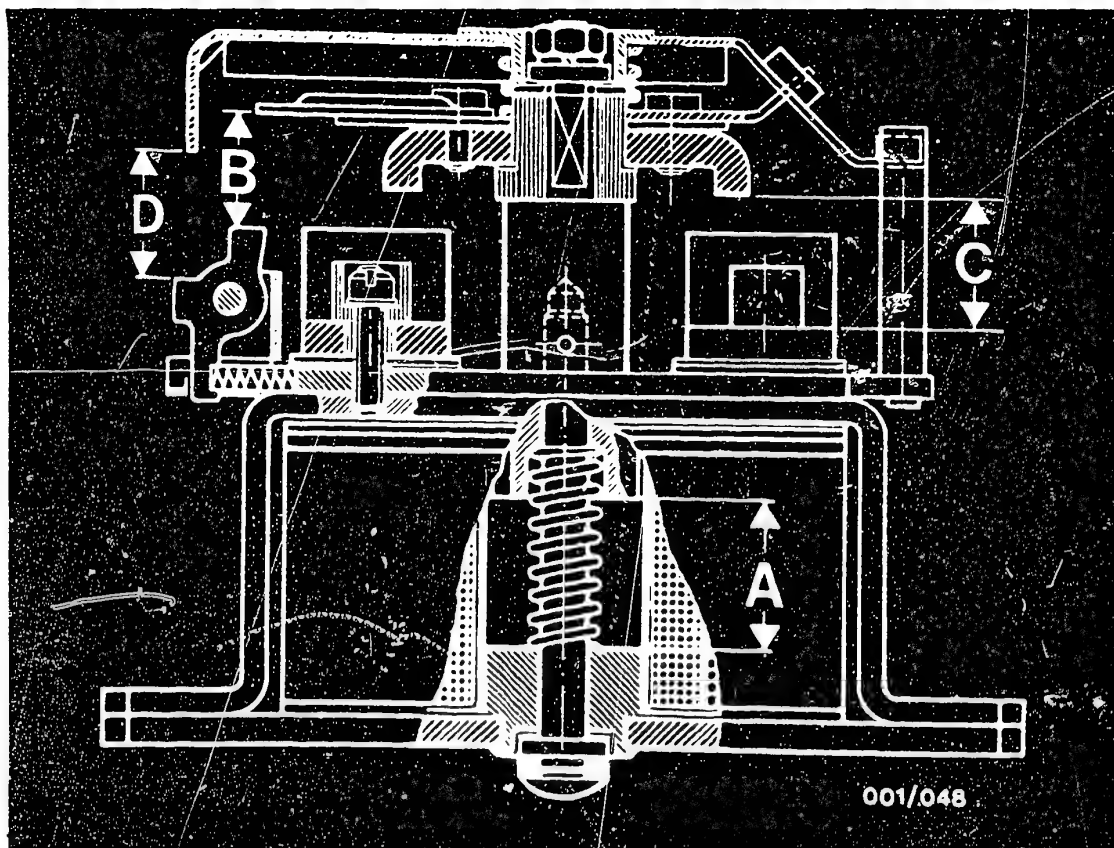
Assemble base plate with solenoid winding (37/1) and contact support. Force 2 spring pins (in base plate) into the two holes of the contact support.

Grease magnetic core with special lubricating grease 5 932 240 150 (VS 10832 Ft) and insert. Do not forget compression spring (37/42).

Angular contact supports (37/27) which have been replaced must be aligned parallel and flat with respect to each other.

Do not yet drive straight pin (37/800) into pressure cap.

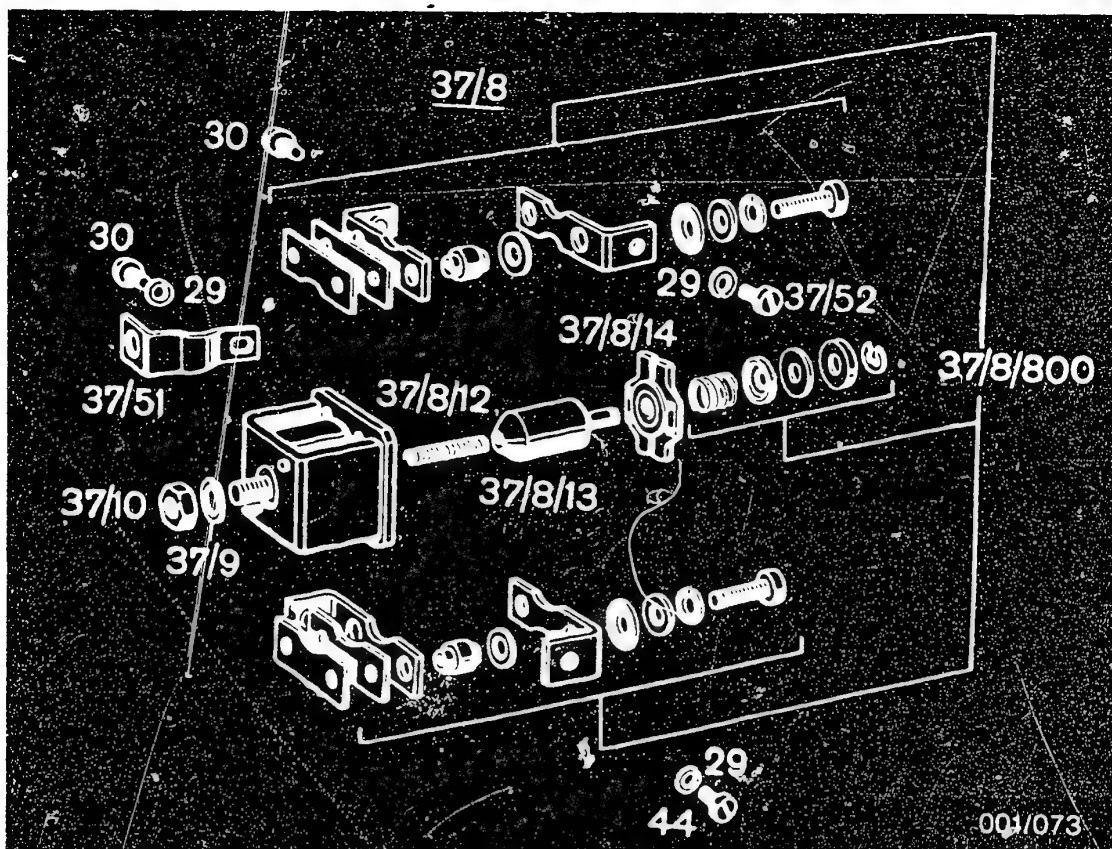




Adjust solenoid switch

- A = Stroke of magnetic core: 25 ± 0.2 mm.
Adjust by turning the pressure cap (8 mm fine-pitch thread).
Then drive in straight pin.
- B = Clearance between locking lever and ratchet lever:
 19.8 ± 0.3 mm. Use shims.
- C = Clearance between bus bar and bridging
contact member 22.4 ± 0.3 mm.
- D = Clearance between release lever and ratchet lever:
 23.5 ± 0.5 mm. Place shims under release lever.



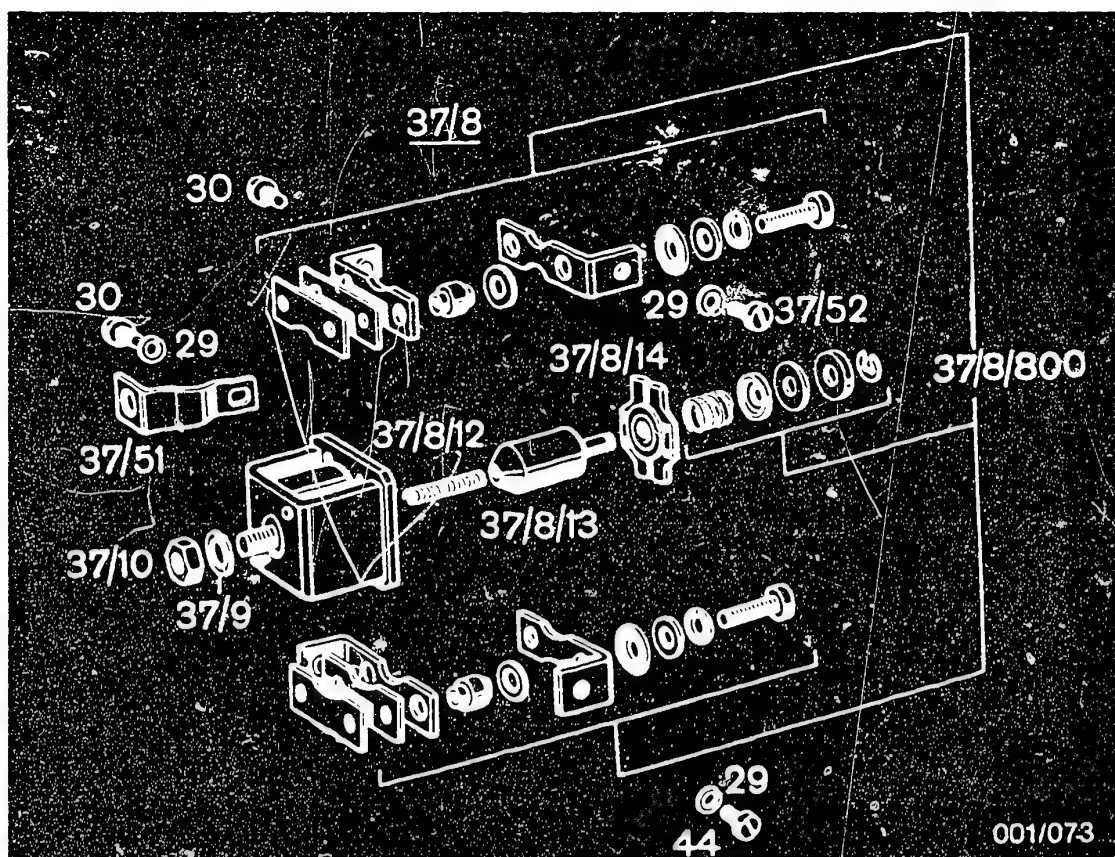


Examine and repair power relay (control relay)

Test winding of power relay (37/8) for open circuit, short circuit and internal resistance. Use commercially available ohmmeter or Bosch tester WPG 012.00.

Internal resistance of winding approx. 5 ohm.

Replace contact bars if burned. In case of defective winding, replace complete power relay.



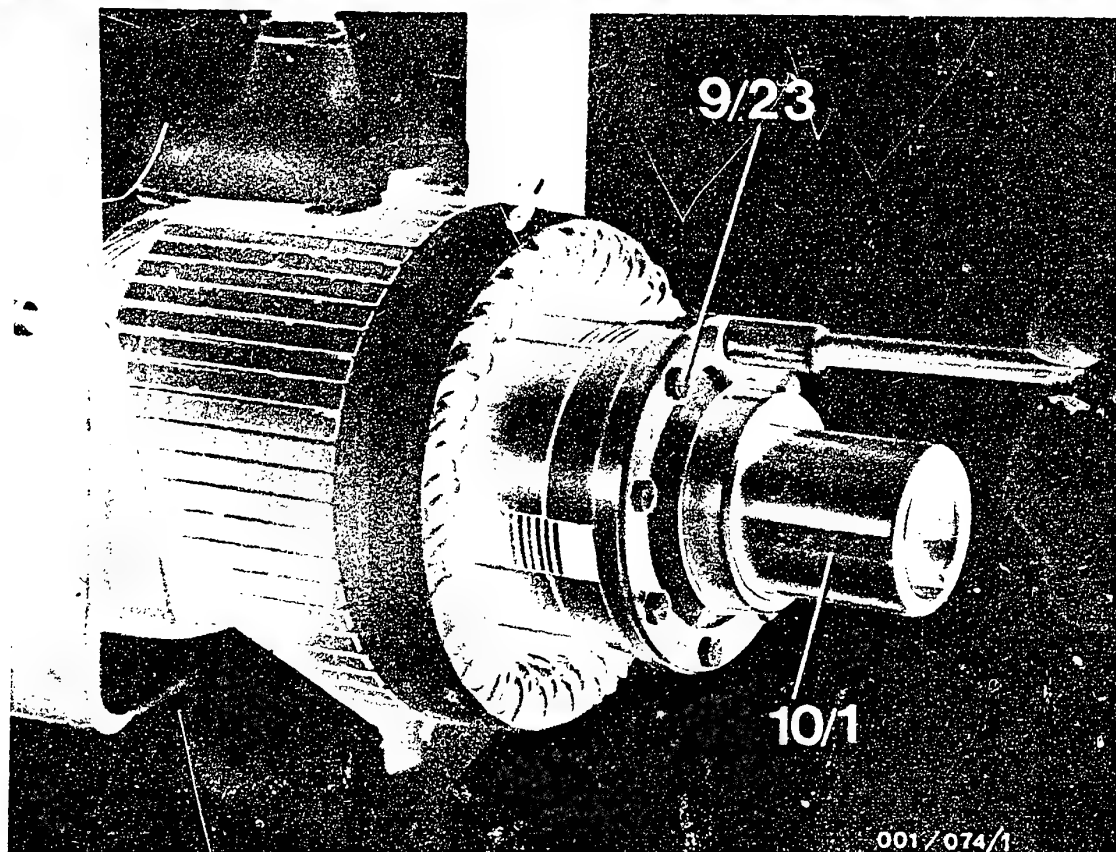
Adjust power relay (control relay):

Contact bars on power relay (37/8) must be aligned parallel and at equal height. Height equalization by means of shims under the insulated spacer rollers. Armature travel with completely installed power relay: 3.3 ± 0.2 mm.

Adjust likewise by means of shims under the insulated spacer rollers.

Shims are included in the parts set.





12. Assembling the starting motor

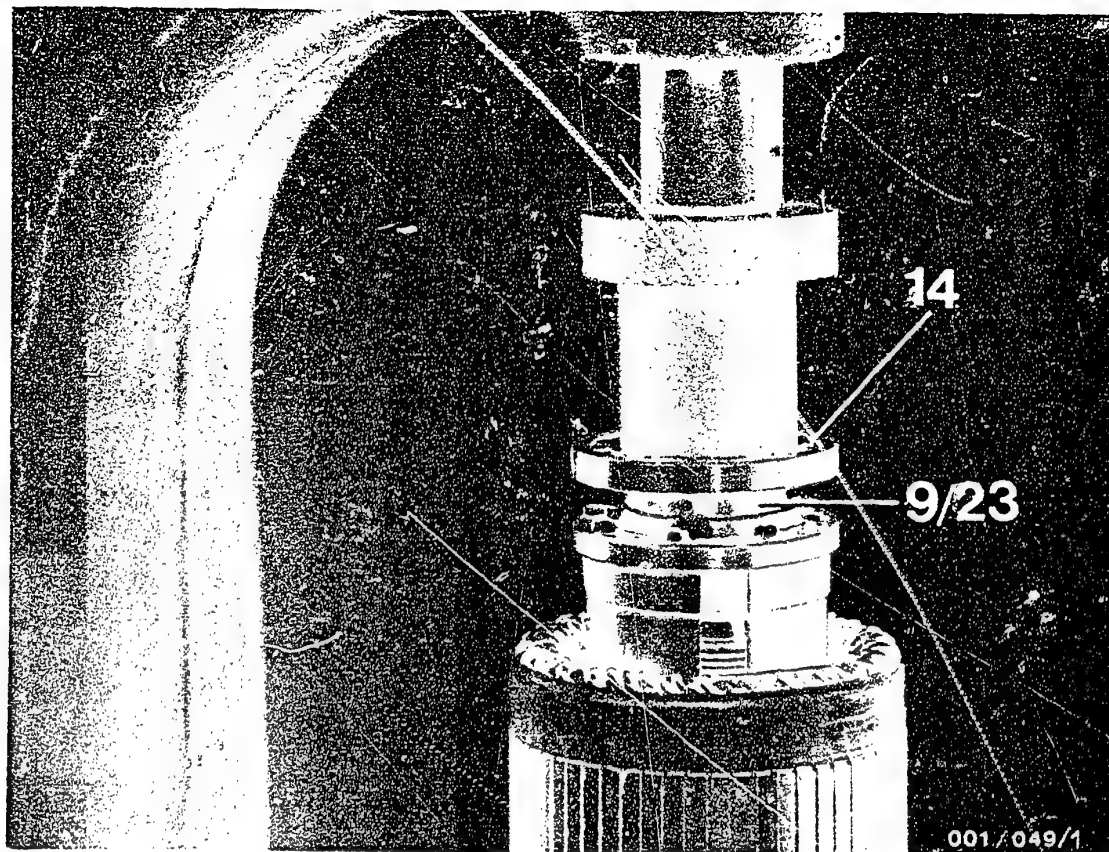
Clamp armature in clamping support and insert drive spindle (10/1) complete with clutch into armature. Mount intermediate bearing (9/23) and screw down (7-8 Nm) - using new micro-encapsulated bolts. Note position of the 4 spring pins.

D 13

Assembling the starting motor

T-Type starting motors 0 001 6..., 24 V





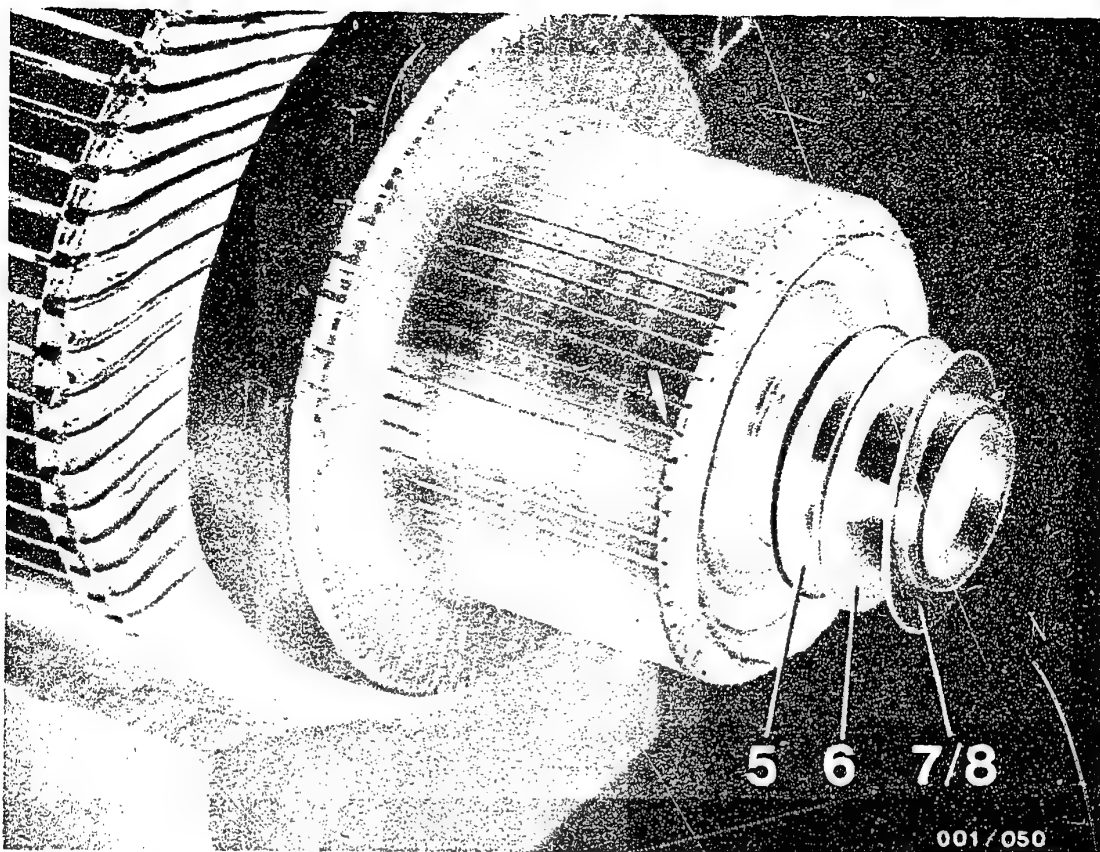
Press on new deep-groove ball bearing

Grease deep-groove ball bearing (14) with special lubricating grease 5 932 240 150 (VS 10832 Ft) and, using suitable thrust member (e.g. pipe piece), press onto intermediate bearing (9/23) at inner race with arbor press.

Grease sealing lip of radial-lip-type oil seal with special lubricating grease 5 932 240 150 (VS 10832 Ft). Slip drive-end-bearing housing (15) onto intermediate bearing (not shown).

Warning! do not damage sealing lip of radial-lip-type oil seal.

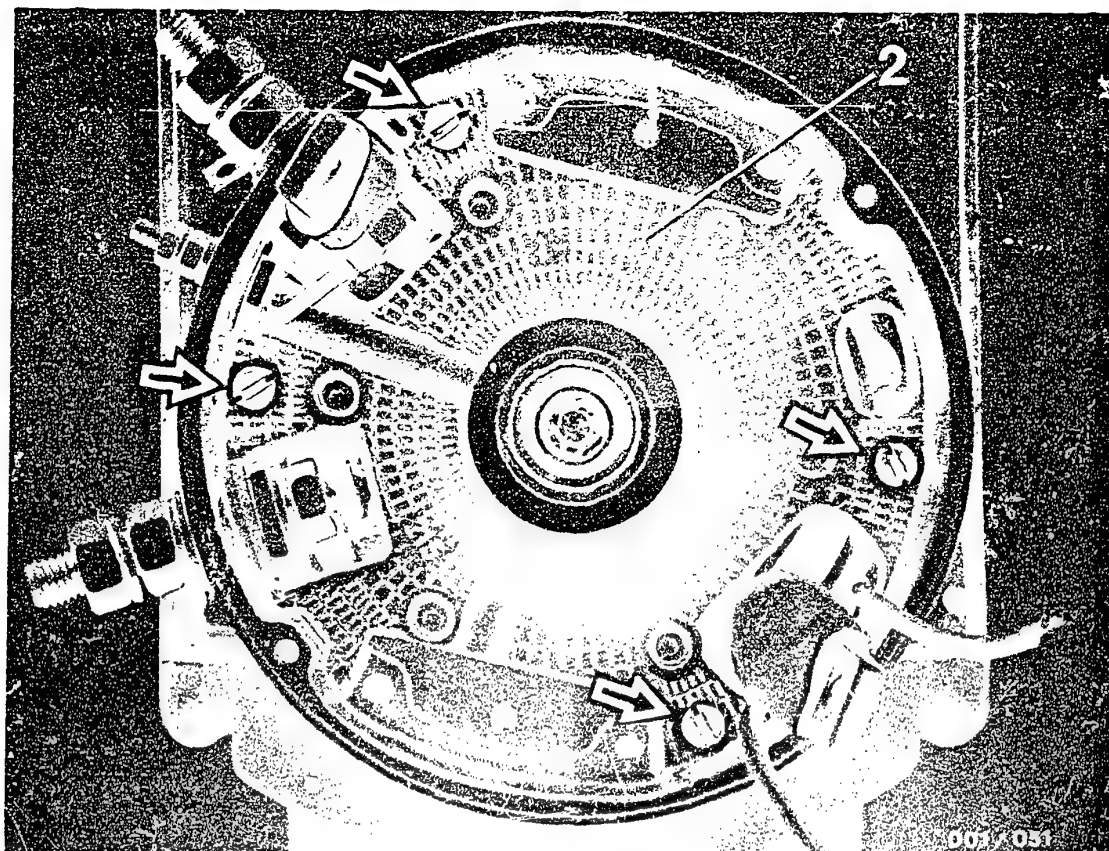




Finish off armature

Slip on shim (steel shim) (5), insulating washer (6) and shim (7)/(8) on the commutator end.





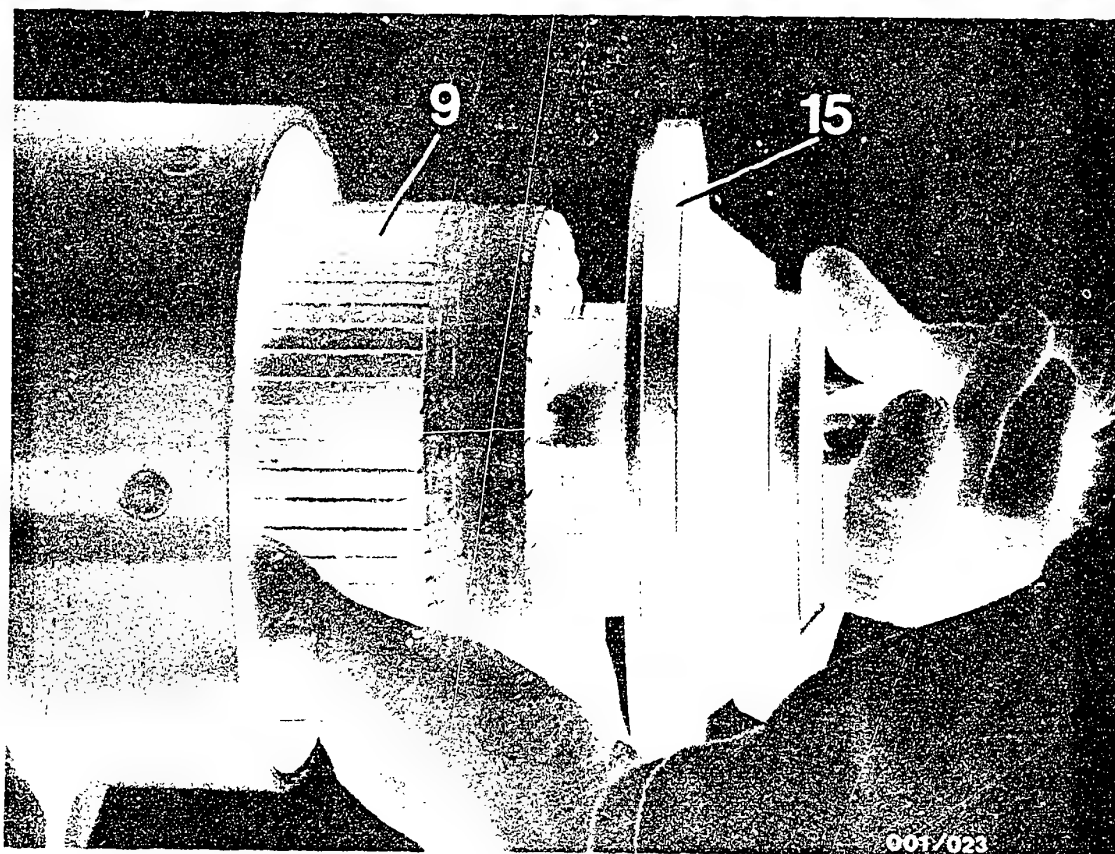
Fit commutator end shield

Clamp stator frame in clamping support.

Place commutator end shield (2) on stator frame - pay attention to straight pin (locating pin) in stator frame. Screw down commutator end shield (2) - not forgetting insulating tubing - and caulk screws (4) (arrows).

Only in the case of TF starting motor 0 001 613 001, before fitting, coat surfaces between stator frame and commutator end shield with sealant "Hylomar" 5 927 350 002 (VS 9844 Kk).





Fit armature

Slip armature (9) with drive-end-bearing housing (15) into stator frame.

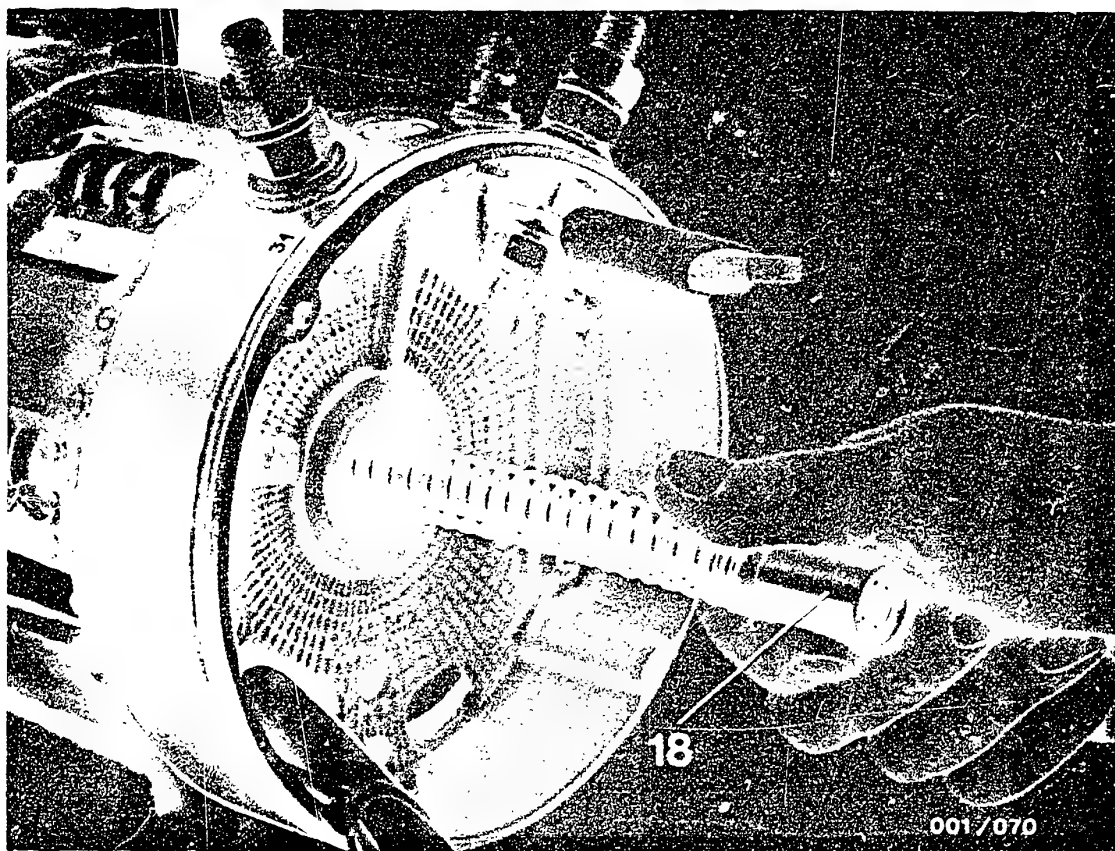
Screw down drive-end-bearing housing (15) with 2 screws and measure longitudinal play of armature: set value = 0.2 ... 0.4 mm.

Adjust using shims (7) or (8).

Measuring point: armature pin on commutator end.

Then fasten drive-end-bearing housing (15) with all screws.

On starting motors with micro-encapsulated bolts use new micro-encapsulated bolts.



Fit armature shaft

Grease armature shaft (engagement shaft) (18) with special grease 5 932 240 150 (VS 10832 oil) and slide into armature from commutator end shield without parallel key.

Note:

As of January 1978 (FD 821) new armature shafts and new pinions are being used.

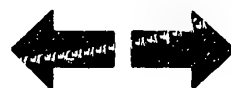
New pinion fits new and old armature shafts.

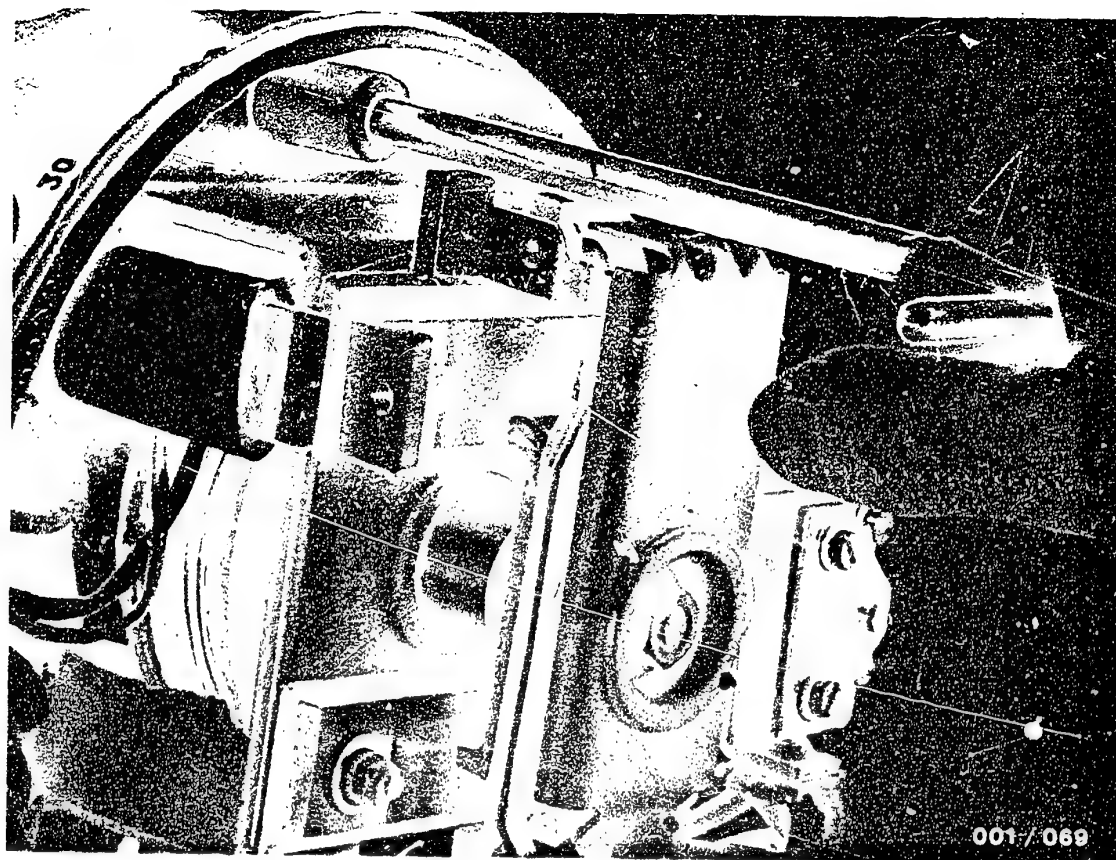
New armature shaft only fits new pinion!

D18

Assembling the starting motor

T-Type starting motors 0 001 6.., 24 V





Screw on solenoid switch with power relay
(control relay).

First of all, fit terminal 50 (parts set). Ensure the correct order of the parts.

When screwing on the solenoid switch, the armature shaft (engagement shaft) is pre-tensioned by the magnetic core of the solenoid switch.

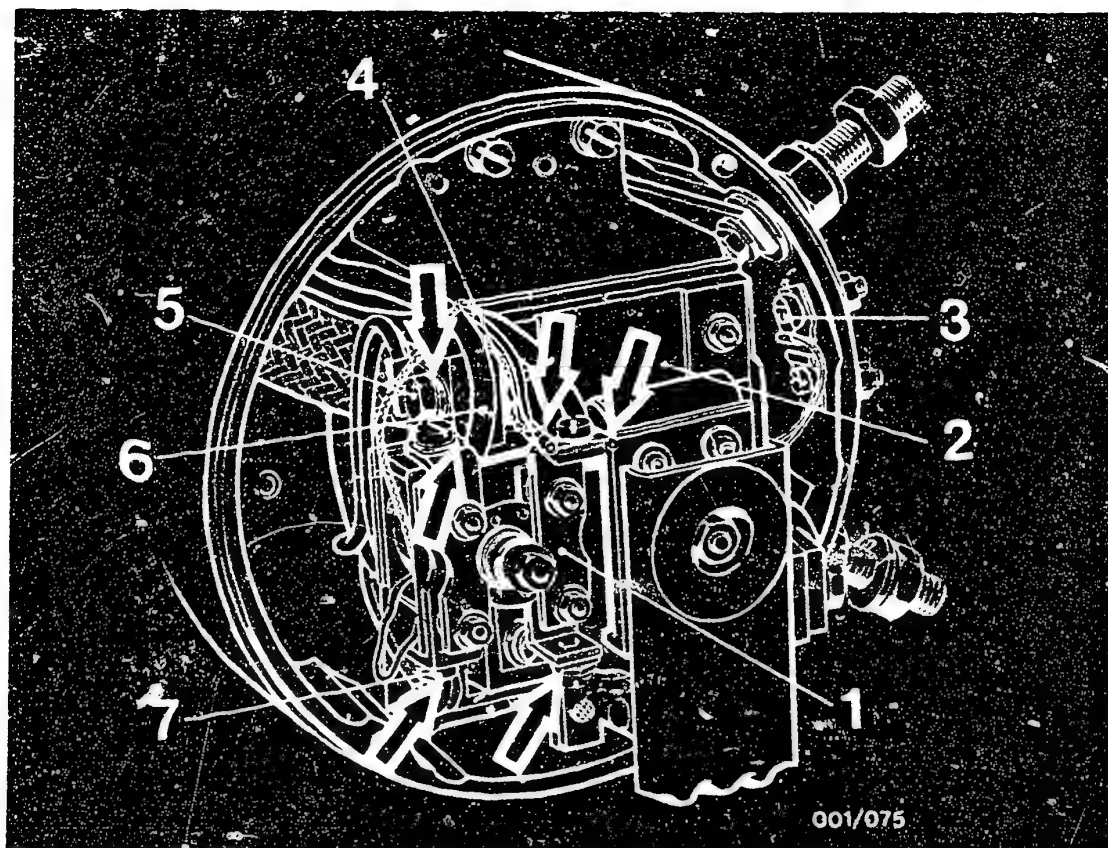
When screwing in the two long fillister-head screws do not forget the insulating tubing.

D19

Assembling the starting motor

T-type starting motor 0 001 5 ..., 24 V





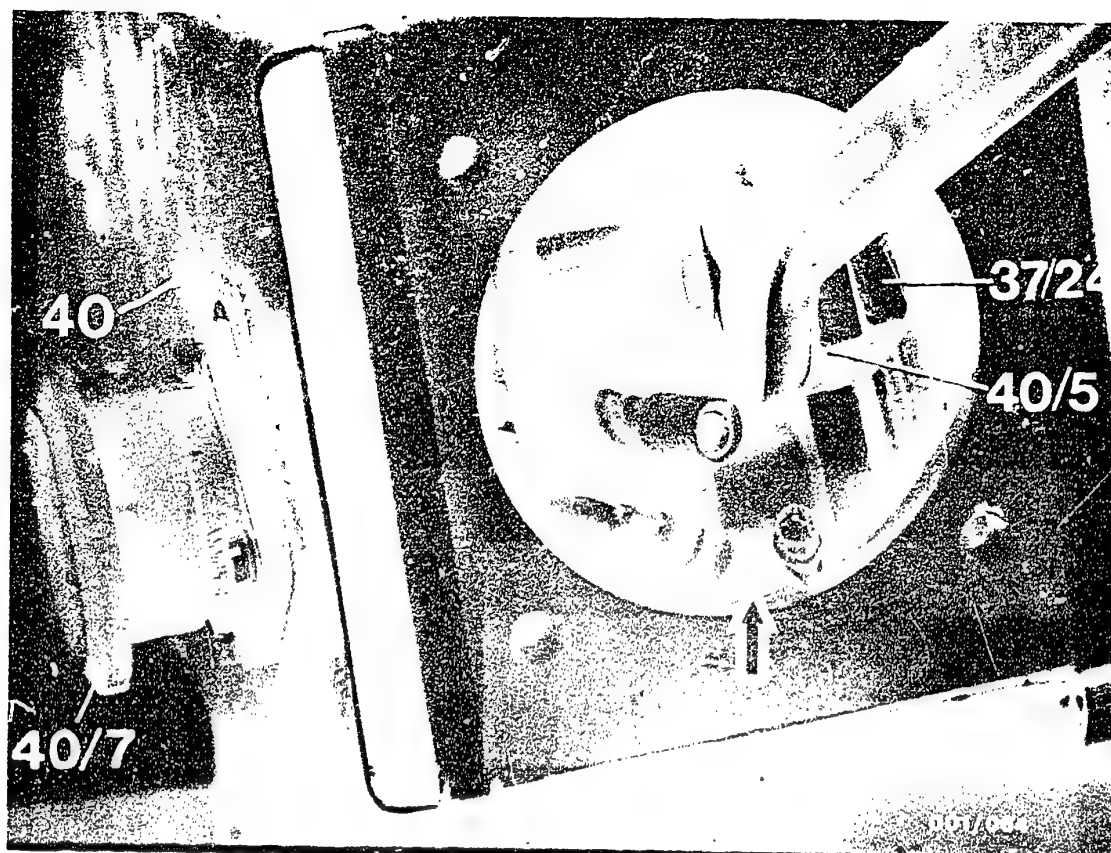
- | | |
|--|--------------------------------------|
| 1 Power relay (control relay) | 5 Start of opposing winding - black |
| 2 Solenoid switch | End of pull-in winding - black |
| 3 Start of solenoid winding of control relay - yellow | 6 Connection of brake field - yellow |
| Start of holding winding - blue | 7 Start of pull-in winding - yellow |
| 4 End of solenoid winding of control relay - yellow | End of opposing winding - white |
| End of holding winding and negative connecting cable - red | |

Connect solenoid switch with power relay

Starting motors in general:

Hold cable lugs with pliers when tightening so that they cannot turn (arrows). This prevents any contact with other parts of the switch.





Connect solenoid switch with power relay

TF starting motor 0 001 613 001

Fit closing cover (40) with bushing (40/7) and cable connections (pin terminals). Insert pin terminals into pin receptacles (arrow). Only connect leads of the same colour. Tie all cables together with cable strap.

Blue/blue = 2 leads to terminal 50 (AB)

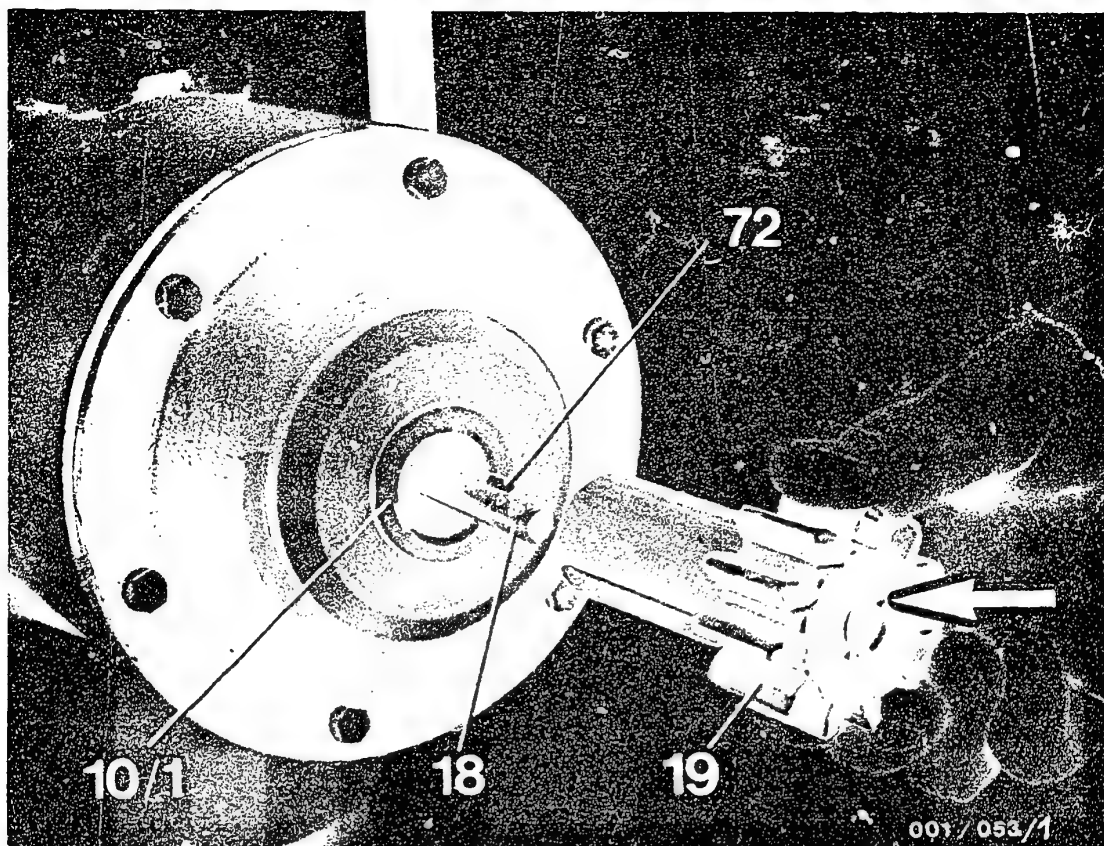
Green/green = 2 leads to terminal 50z (DE)

Red = lead to terminal 48 (C)

White = lead from terminal 30 (F)

Screw flat cable (40/5) onto contact bar (37/24) of solenoid switch.

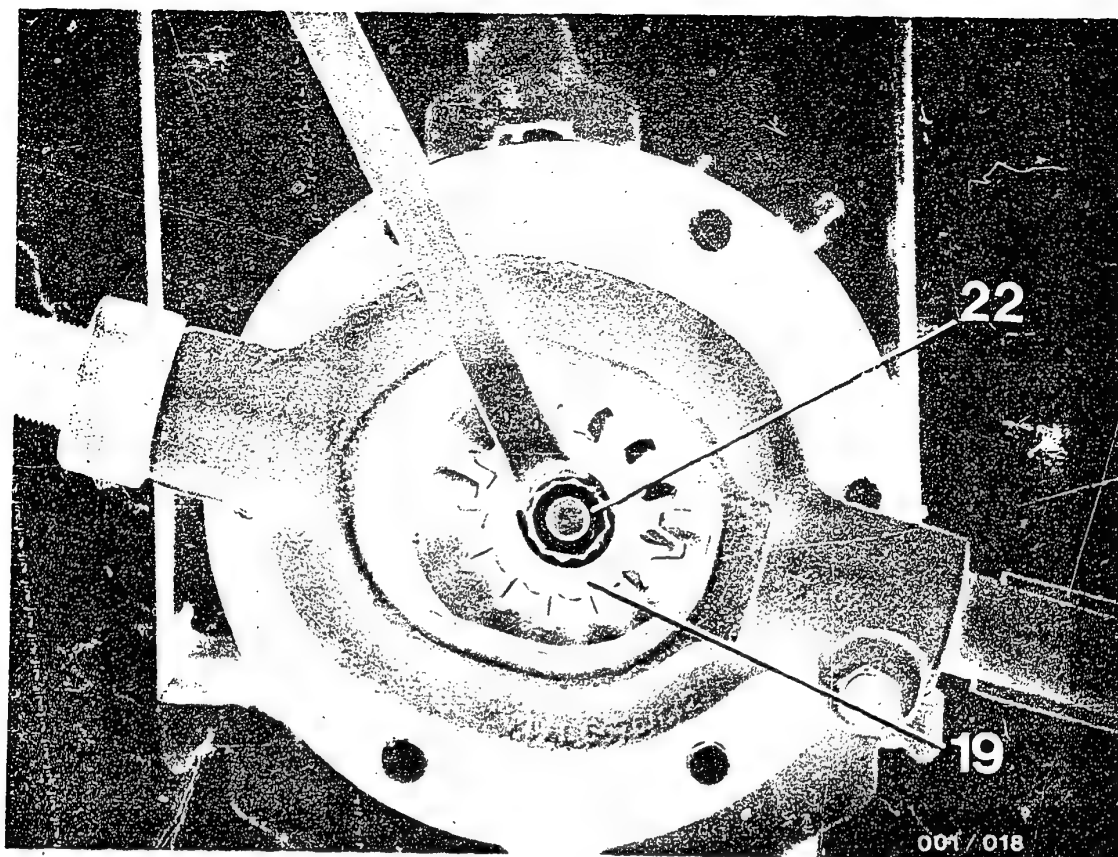




Fit starting-motor pinion

TB starting motors 0 001 600 .., .. 601 ..,
 Insert parallel key (72) in armature shaft (engagement shaft) (18). Slip starting-motor pinion into armature shaft (10/1). Turn starting-motor pinion until groove in starting-motor pinion is pointing vertically upwards. Take out starting-motor pinion again. Turn armature shaft (18) so that parallel key (72) is pointing vertically upwards. Carefully re-introduce starting-motor pinion (19): Parallel key (72) must mate with groove in starting-motor pinion.





Fit starting-motor pinion - TB starting motors
0 001 600 ..., .. 601 ..

To repair an old starting motor with a new engagement shaft (change as of FD 822) it is necessary to use a new pinion. New pinions (with a groove in the bore) can also be used for the old engagement shafts (with locking washer).

Insert starting-motor pinion (19), holding with torque-meter KDAL 5476. Always use new Uni-Stop nut (22) and tighten to a torque of 35 ... 45 Nm (3.5 ... 4.5 mkgf). Turn over armature by hand - it must run easily without the carbon brushes fitted.



Comparison of pinions.

If an old pinion is ordered, the new version is automatically supplied.

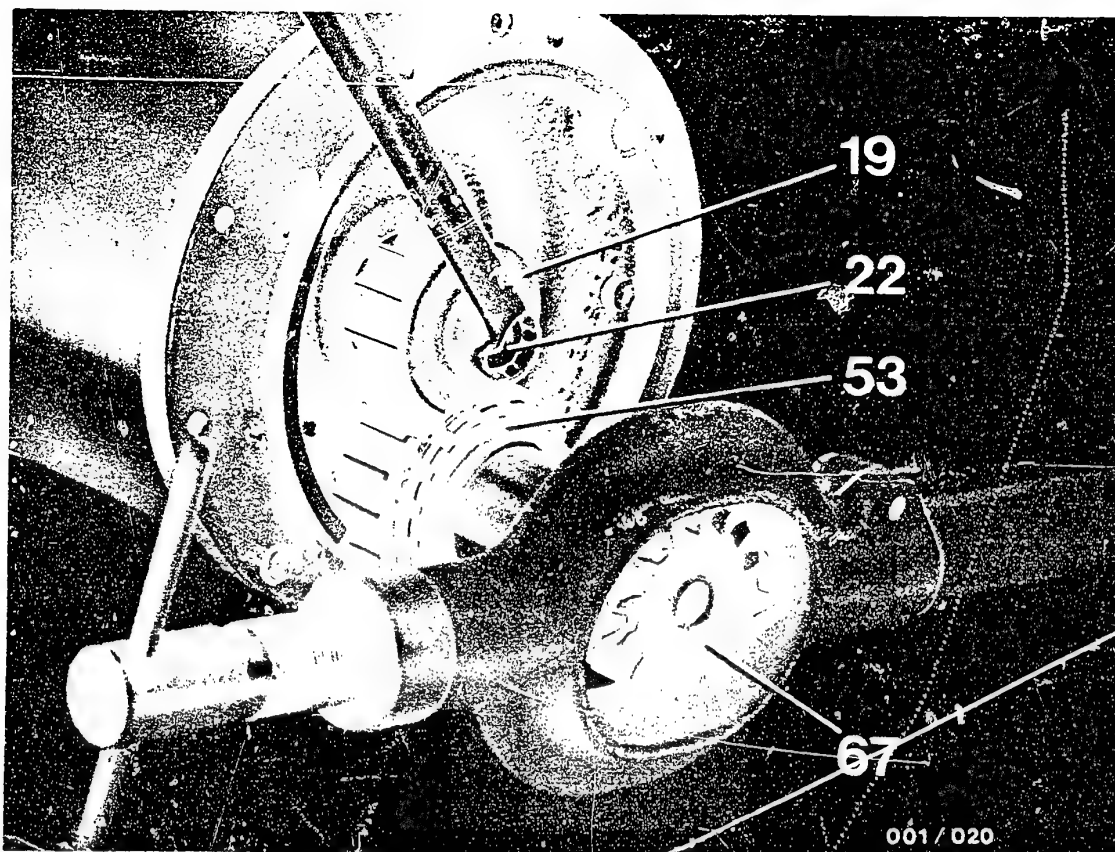
Old version				New version				Old version				New version			
2	006	382	030	1	006	382	130	1	006	382	002	1	006	382	102
			031				131				003				103
			034				134				004				104
			035				135	2	006	383	030		383		130
			036				136				031				131
			037				137				034				134
			038				138				035				135
			039				139				036				136
			041				141				037				137
			048				148				038				138
											039				139
											042				142
											043				143

E1

Assembling the starting motor

T-Type starting motors 0 001 6.., 24 V





Fastening the pinion on TF starting motors
0 001 608 ..., .. 611 ..

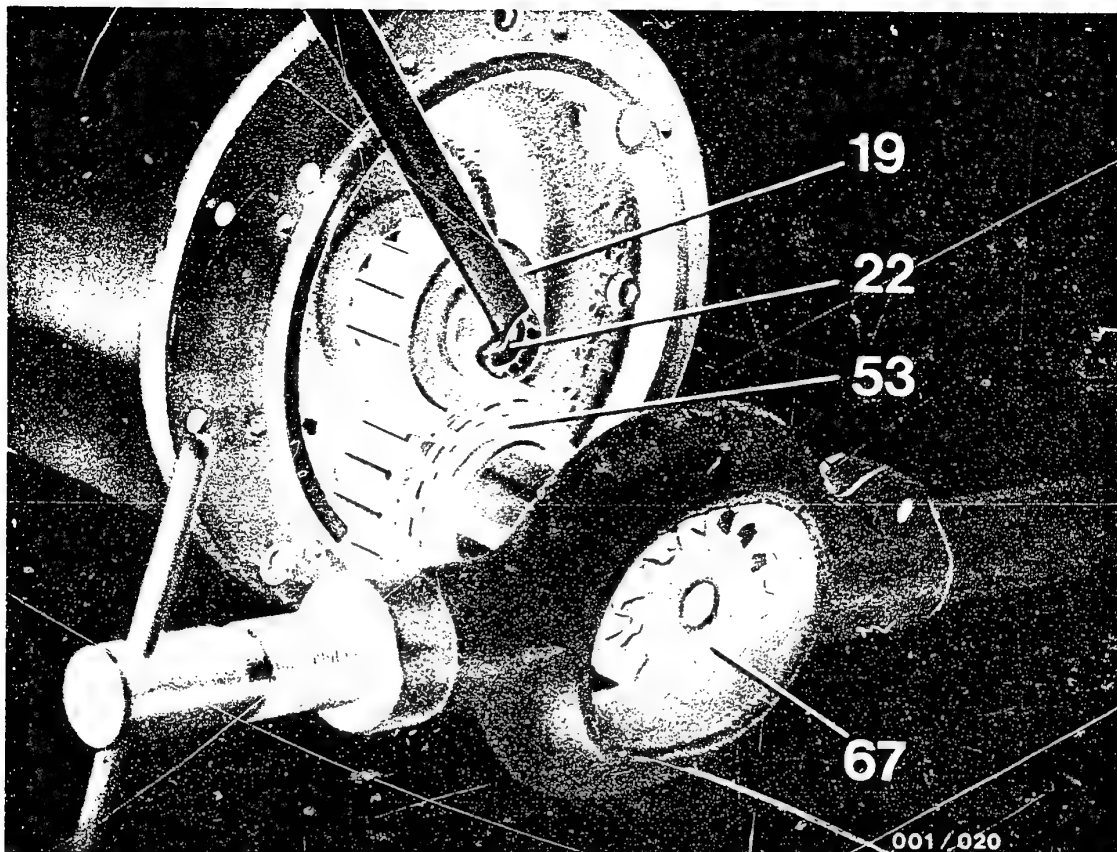
Fit inner drive-end-bearing housing. Insert pinion (19) in armature shaft with parallel key (20). Screw down starting-motor pinion (19).

Use new Uni-Stop nut (22).

Tightening torque: 35 ... 45 Nm (3.5 ... 4.5 mkgf).

In order to tighten Uni-Stop nut (22), first of all insert starting-motor pinion (67) and hold with torque-meter KDAL 5476. Turn over armature by hand - it must run easily without the carbon brushes fitted.



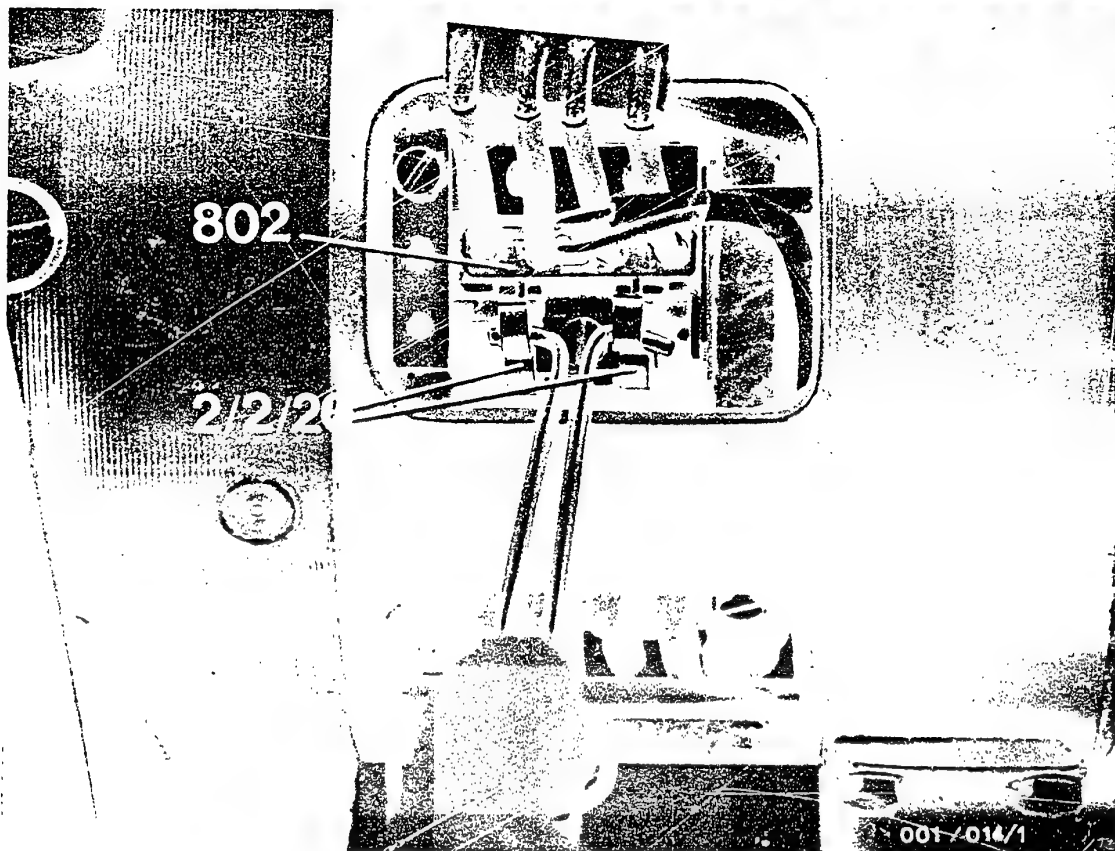


For starting-motor pinion (67) there is no locking washer under fastening screw of outer pinion. New pinion-fastening screw 2 003 450 001 has self-locking Loc-Wel strip. Use only such screws from now on. In emergencies it is possible by way of exception to continue to use the old version with a tab washer. The locating hole for the locking washer is still in the end face of the pinion.

Tightening torque for fastening screw

old version: 30 ... 40 Nm (3 ... 4 mkgf),

new self-locking version: 40 ... 50 Nm (4 ... 5 mkgf).



Fit carbon brushes

Lift up compression springs (2/2/8) using suitable wire hook and fit carbon brushes (802).

Route the connecting cables of the carbon brushes (802) after fitting so that the carbon brushes can be easily moved in the brush holders. Minimum length of carbon brushes: 17 mm

Brush pressure

If the brush pressure is too high, there will be excessive wear on the carbon brushes and on the commutator.

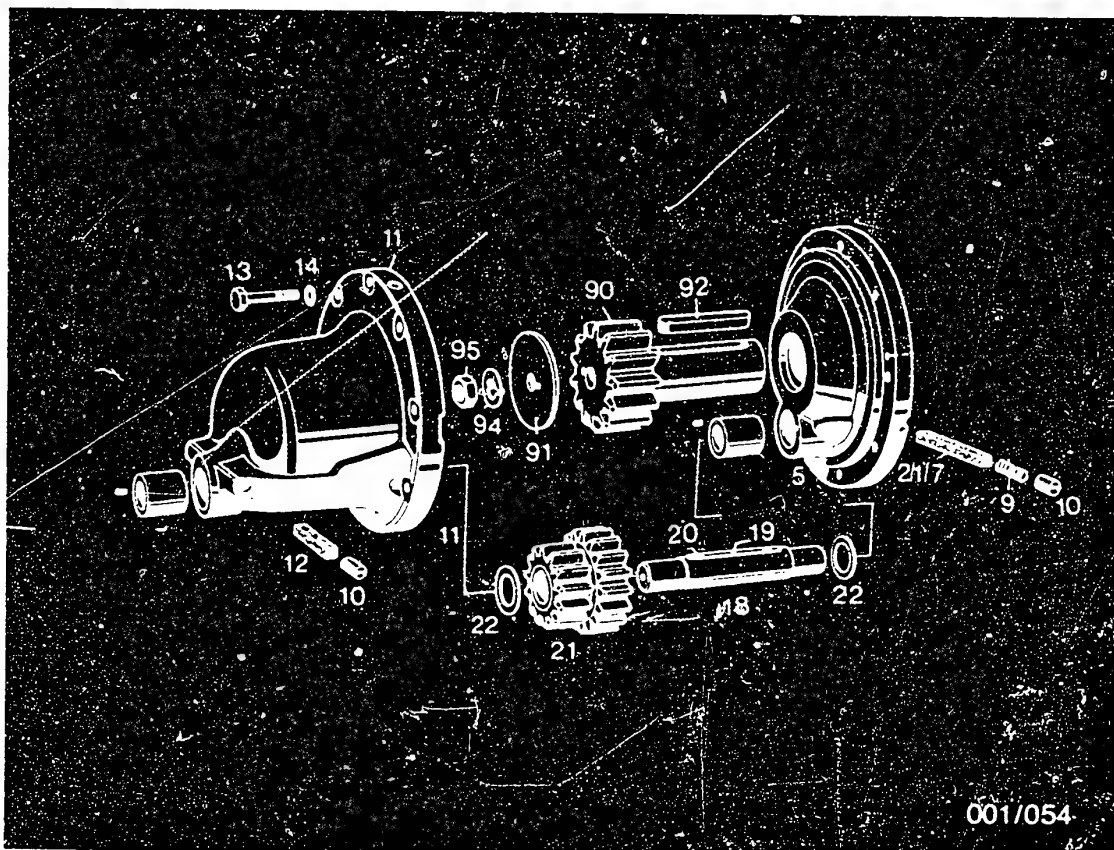
If the brush pressure is too low, there will be heavy brush arcing.

The commutator will suffer burning, and the starting motor will not deliver its full power.

Brush pressure: 13 - 16 N per spring.

In the case of TF starting motor 0 001 613 001 = 14 - 15 N.





Assembling the intermediate transmission

TE starting motors 0 001 602 ..., .. 603 ...

Note order of parts (see picture).

Thoroughly grease the individual parts with special lubricating grease 5 932 240 150 (VS 10832 Ft).

Observe the longitudinal play of the intermediate-transmission shaft (18) = 0.15 ... 0.3 mm.

Remember shims (22) on the intermediate-transmission shaft.

Impregnate lubricating wick (2/1/7) and (12) with silicone oil 5 962 260 605 (VS 13834 01).

Use new Uni-Stop nut (95).

Tightening torque: 28 ... 32 Nm (2.8 ... 3.2 mkgf).

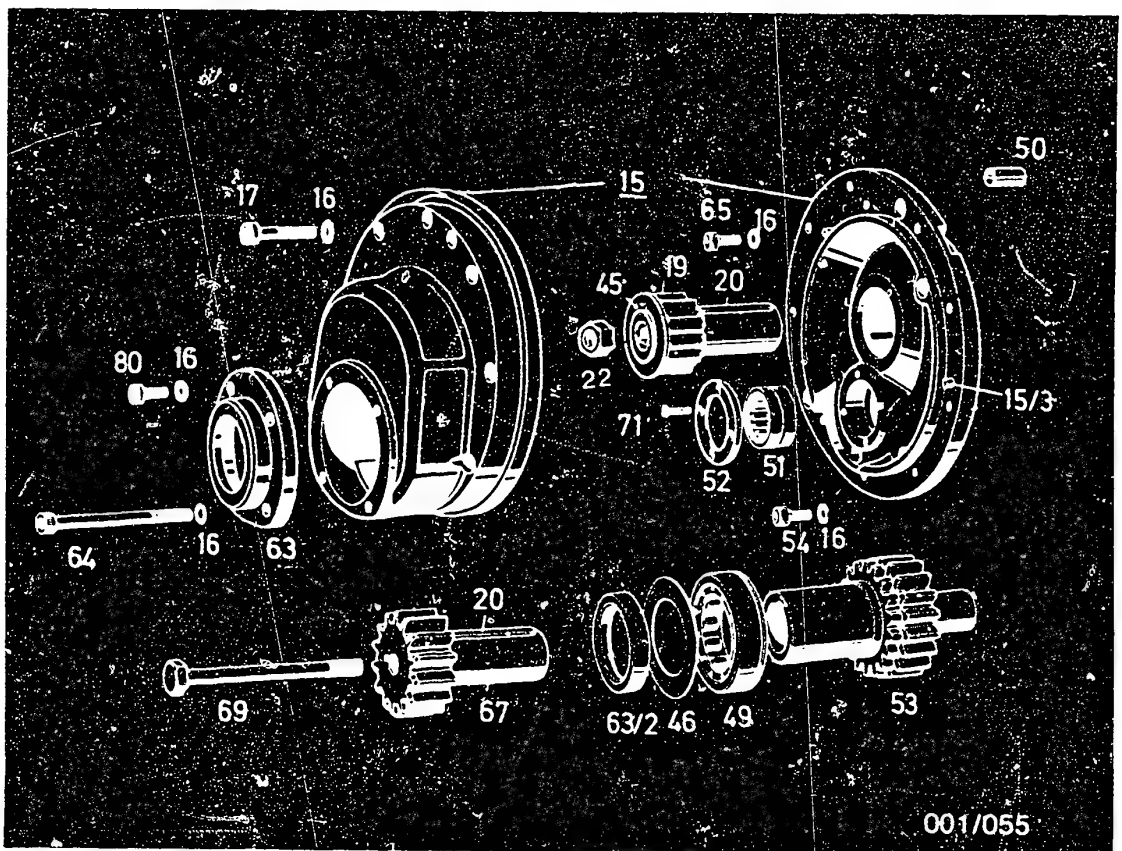
Note: Defective sintered bearing bushings of the armature shaft in the intermediate transmission (47) can only be replaced in PLB or NOW1.

E5

Assembling the starting motor

T-type starting motor 0 001 6 ..., 24 V





Assembling the intermediate transmission

TF starting motors 0 001.611 ..., .. 613 ..., (without control fork).

Grease the following parts with special lubricating grease 5 932 240 150 (VS 10832 Ft):

Starting-motor pinions (19), (53) and (67), cylindrical-roller bearing (49), supporting plate (46) and radial-lip-type oil seal (53/2).

Note different length of screws (17), (54) and (65).

On starting motor 0 001 608 005, pay attention to washer and both seal rings (O-rings) behind the spring lock washer (16).

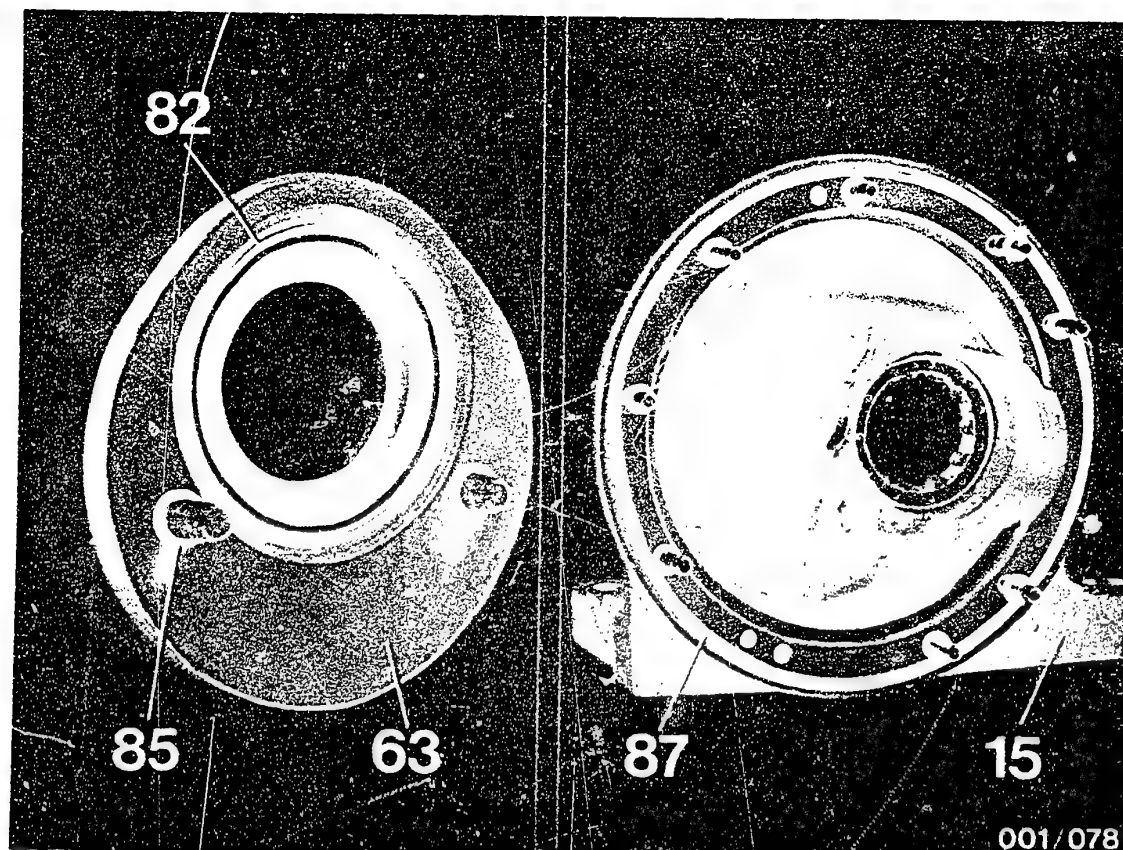
Use new Uni-Stop nut (22).

Tightening torque 35 ... 45 Nm (3.5 ... 4.5 mkgf).

Use new pinion-fastening screw (69) with Loc-Wel strip.

Tightening torque 40 ... 50 Nm (4 ... 5 mkgf).





Assembling the intermediate transmission

TF starting motor 0 001 613 001

Bearing end plate (63): replace O-ring (82) and (85).

Drive-end-bearing housing (15): replace O-ring (87).

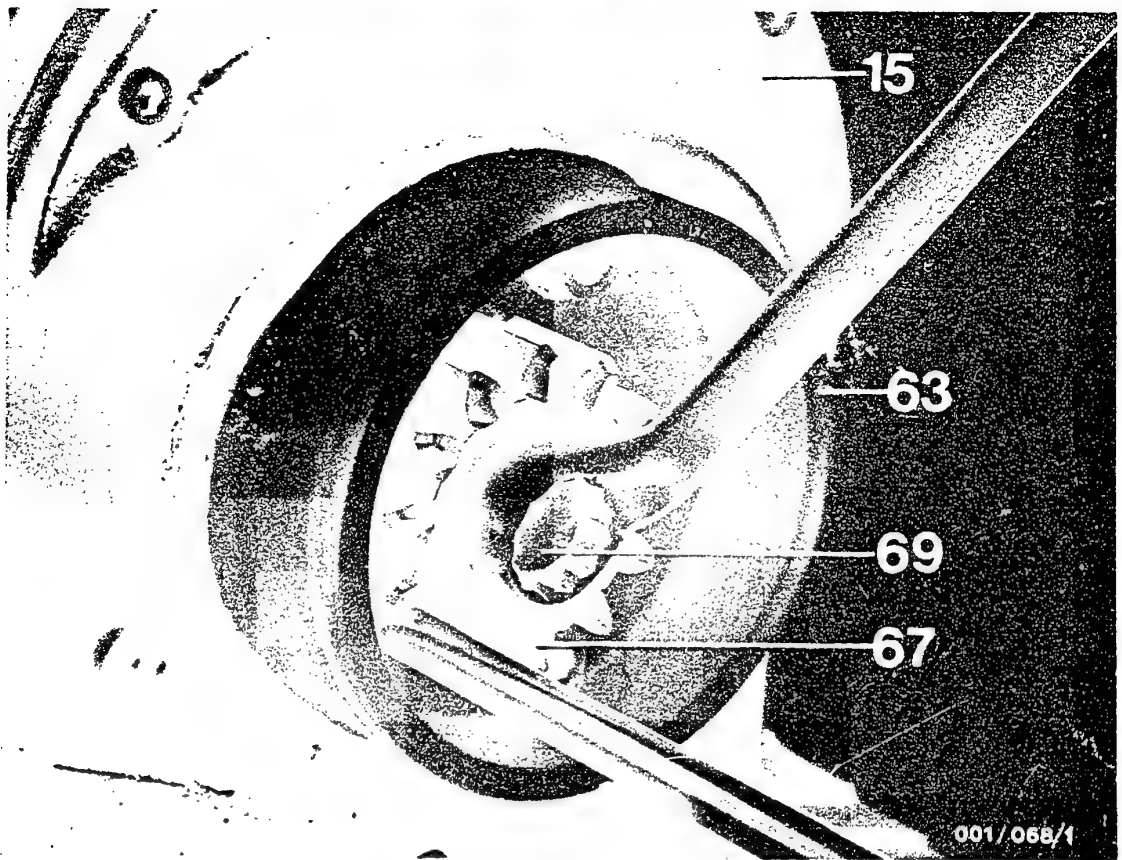
Coat flat machine surfaces on drive-end-bearing housing (15) and bearing end plate (63) entirely with sealant "Hylomar" (5 927 350 002).

E7

Assembling the starting motor

T-type starting motor 0 001 6 ..., 24 V

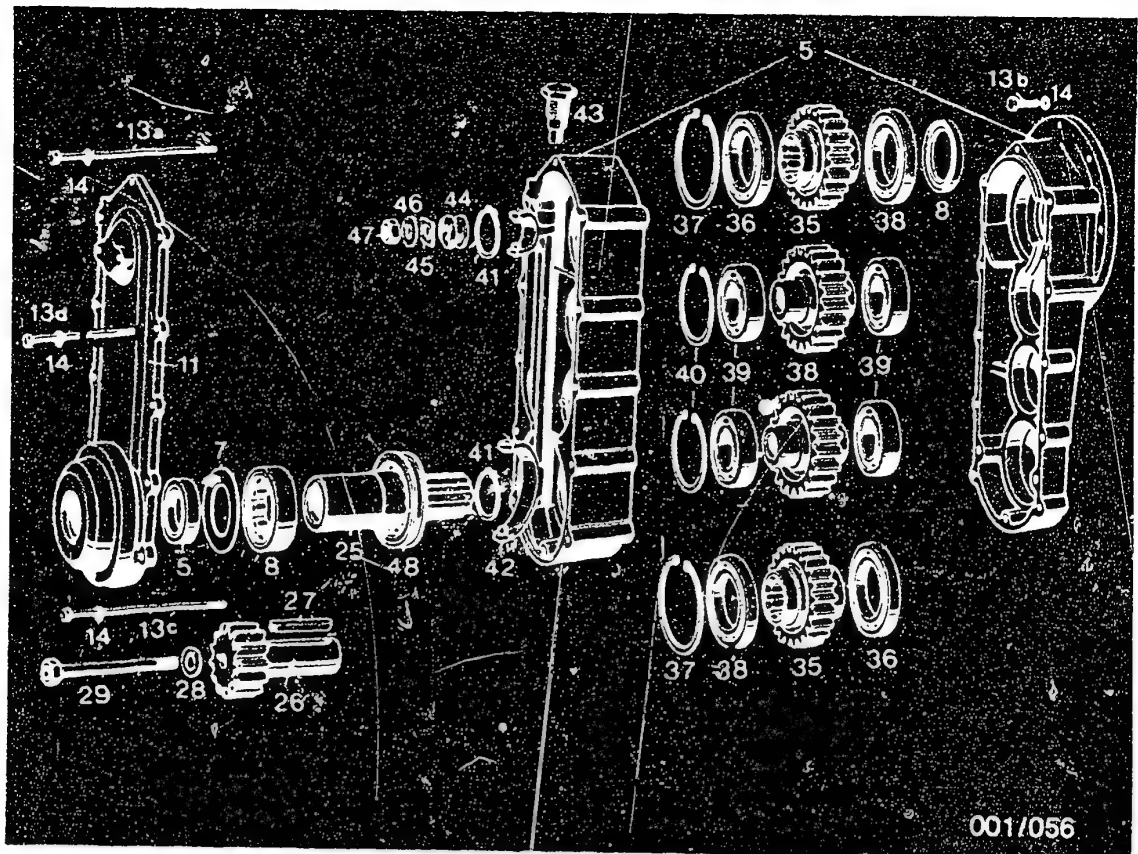




Assembling the intermediate transmission
TF starting motor 0 001 613 001

Insert suitable round stock between starting-motor pinion (67) and bearing end cover (63) of drive-end-bearing housing (15) (see picture).
This blocks the starting-motor pinion when tightening the screw (69).
Tightening torque for screw (69): 42 - 50 Nm.





Assembling the intermediate transmission

TF starting motors 0 001 609 .., with control fork

Grease the following parts with VS 10 832 Ft:

All ball bearings and intermediate-transmission gears.

Seats of ball bearings and intermediate shaft (25).

Guide ring (44) and clutch sleeve (48).

Control forks or fork lever (42).

Bend down edges of tab washer (46) onto washer (45) and nut (47).

Do not tighten screw bolt (43) too firmly -

Axial play of fork lever (42): 0.1 mm.

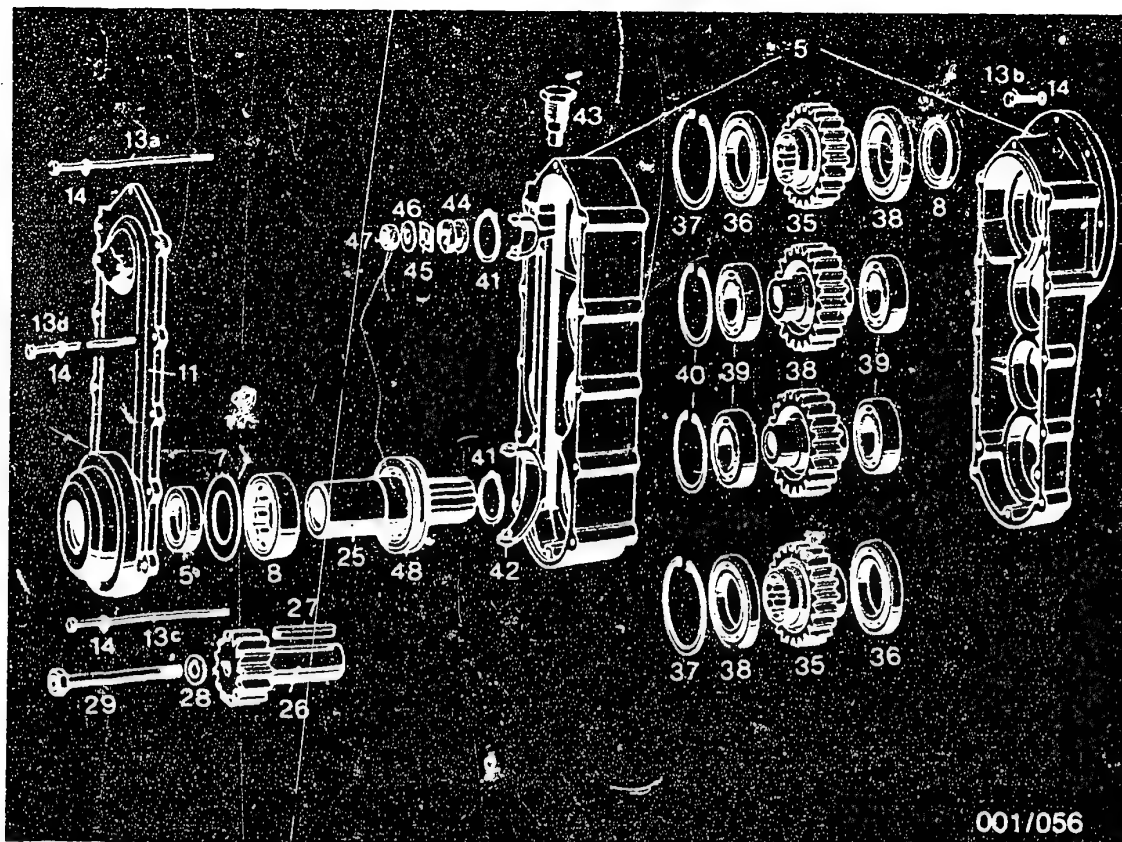
Radial play of fork lever (42): 0.5 mm.

E9

Assembling the starting motor

T-Type starting motors 0 001 6..., 24 V





001/056

When assembling, note: Engagement shaft must align with drive spindle. Drive spindle must align with housing and cap of intermediate-transmission housing (11).

Tightening torque of nut (47): 20 Nm (2.0 mkgf) - fit starting-motor pinion (26) and hold in position with torquemeter KDAL 5476.

Tightening torque for bolts (13): 7 ± 1 Nm (0.7 mkgf)

Tightening torque for bolt (29): 42 Nm (4.2 mkgf)

E10

Assembling the starting motor

T-Type starting motors 0 001 6.., 24 V



13. Testing on the test bench

13.1 General

The following test benches may be used:

EFAL 30 for all 24 V starting motors above 10 kW

} with/without intermediate transmission

EFAL 140 0 001 600 ..., .. 601 ..., .. 602 ..., .. 603 ..., .. 608 ..., .. 611 ..., .. 613 ..

EFAL 152/153 for 24 V starting motors up to 15 kW
without intermediate transmission

0 001 600 ..., .. 601 ...,

Clamp the starting motor properly in position on the test bench. Properly tighten the electrical connections (connecting pins). Make sure there is a good ground connection (connect negative cable of test bench to starting motor).

The electrical test specifications depend on the condition of the battery (capacity and state of charge) and the duration of the test (heating up of the starting motor, discharging of the battery). The test specifications apply only to the test bench and cannot be used for starting motors installed on the engine/ in the vehicle. A small starting motor is more heavily loaded by the battery installed in the test bench, whereas, with the largest types of starting motor, the capacity of the test bench battery is not sufficient to obtain the maximum power. The longer leads which are inevitable in the test bench also influence the power of the starting motor. Therefore, the duration of the test should be as short as possible and the batteries should be properly charged, at least three quarters charged.

In the case of defective starting motors, the measured values differ considerably from the stated test specifications. In this case, disassemble the starting motor once again and repeat the tests on the individual parts.



13.2 Minimum pull-in voltage for solenoid switch (installed on starting motor)

Mount the starting motor on the test bench so that the pinion cannot mesh with the ring gear/gear segment.

Make the electrical connection.

At the minimum pull-in voltage the solenoid switch must still reliably pull in and the starting-motor pinion must mesh.

When the voltage is cut off the switch must drop out immediately.

Minimum pull-in voltage:

Starting motor	V
0 001 600	14
602 001	14
602 002	14
603 001	14
603 ...	14
0 001 601 ...	12
608 ...	12
0 001 611 ...	13
613 001	13



13.3 No-load test

Switch on the starting motor.

Measure the current consumption, voltage and rotational speed.

The no-load test specifications are given in the table below.

Starting motor	V	A	min ⁻¹
0 001 600 ...	22.5	<115	6000
601 ...	22.5	<170	6000
602 001	22.5	<115	4100
602 002	22.5	<115	4800
603 001	22	<170	5800
603 ...	22	<170	4200
608 ...	23	<140	3700
608 001	23	<170	3500
608 002, 003, 005	23	<140	3700
608 004, 006, 007	23	<140	6000
611 ...	23	<130	4000
613 001	23	<210	4900

13.4 Short-circuit test

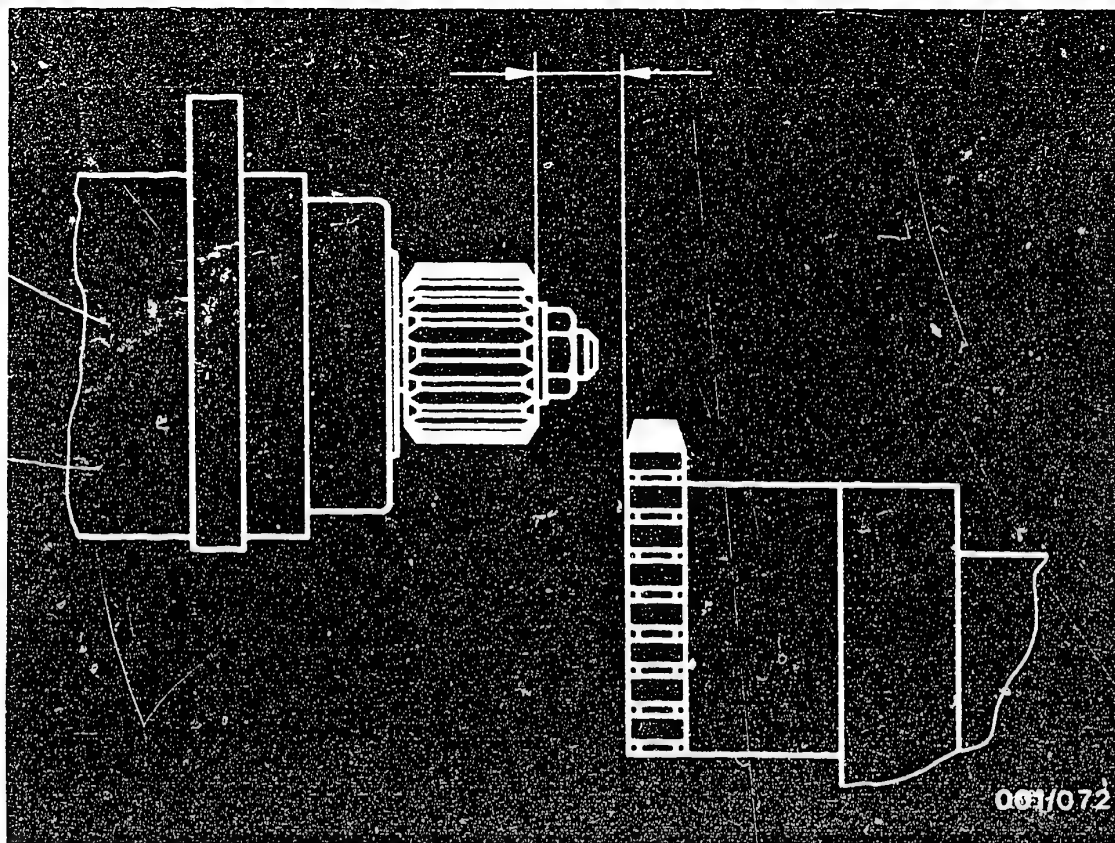
The ring gear of the test bench and the starting-motor pinion must have the same teeth (same module). Otherwise, replace the ring gear of the test bench.

Note:

The module of the starting-motor pinion can be seen in the starting-motor specifications.

Relocate the starting motor (push forward), noting the pinion clearance and backlash.





13.4.1 Pinion clearance

The pinion clearance is the clearance between the ring gear and the end face of the pinion with the starting motor in the rest position.

If the clearance is too great, the pinion will not sufficiently mesh with the ring gear; the pinion teeth and gear ring teeth do not have sufficient contact and are, therefore, heavily loaded on one side. The minimum clearance is necessary so that the pinion reliably demeshes, so that it does not strike against the moving ring gear in the case of heavy vibration and also so that it cannot mesh in so far that the pinion shaft comes up against the ring gear.

Pinion clearance for all T-type starting motors
3.0 ... 4.0 mm



13.4.2 Backlash

The backlash is the distance (play) between the tooth flanks of the meshed pinion and those of the ring gear/gear segment.

To make the measurement, mesh in the pinion by hand and hold it in this position. Using a feeler gauge, test the backlash. (Not possible if starting motor is installed in vehicle).

If the play is too little or too great, this leads to heavy wear on the teeth and can even cause entire teeth to break off.

Backlash for all T-type starting motors 0.7 ... 0.9 mm



13.4.3 Test procedure

Set the measuring-range selector switch.

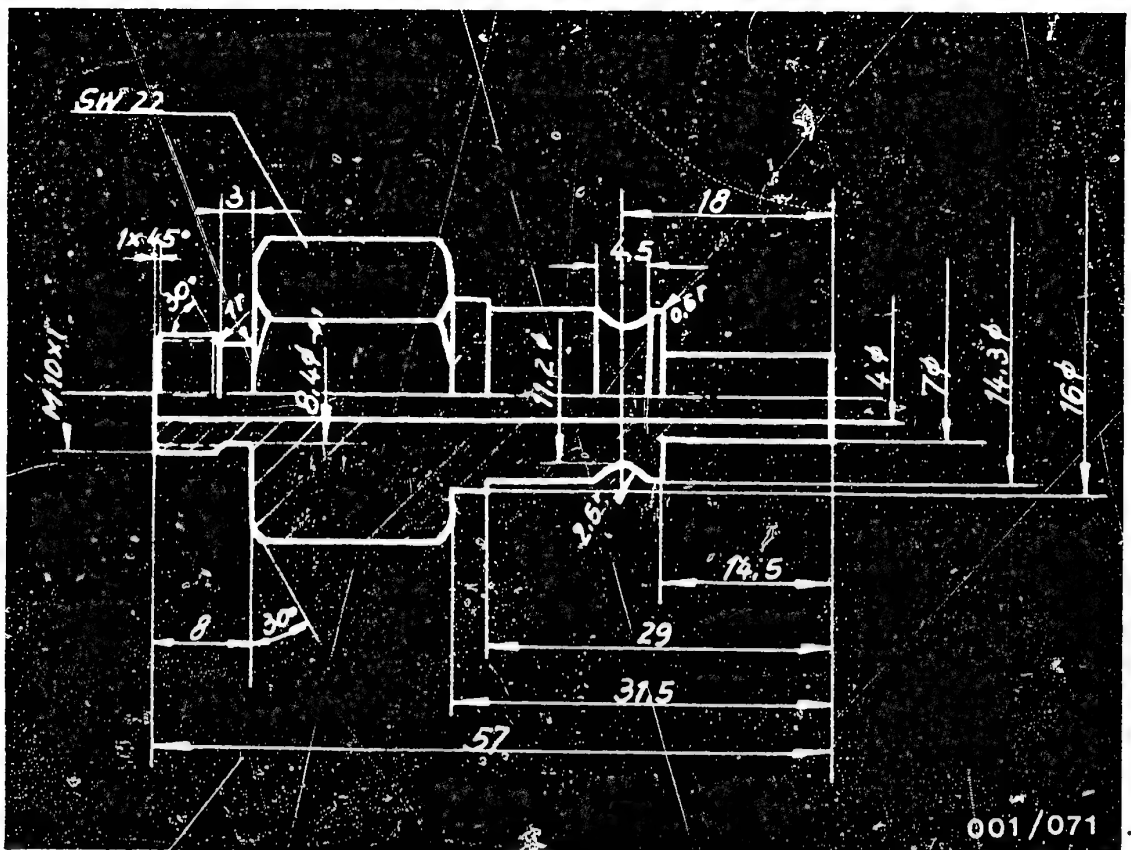
In the case of test benches with gear/ring gear, switch on the starting motor and slow down until it comes to rest. Read off the test specifications. Perform the test only briefly, for a maximum of 1 to 2 seconds.

In the case of test benches with a fixed gear segment, briefly switch on the starting motor and read off the test specifications.

The short-circuit test specifications are given in the table below.

Starting motor	V	A	Md(Nm)
0 001 600 ...	8	1400 - 1570	133
	7	1200 - 1380	177
601 ...	5	1700 - 1910	155
	4.5	1510 - 1730	140
602 001	8	1400 - 1590	205
	7	1220 - 1400	180
602 002	8	1400 - 1590	185
	7	1220 - 1400	160
603 001	5	1700 - 1910	145
	4.5	1510 - 1730	130
603 ...	5	1700 - 1910	145
	4.5	1510 - 1730	130
608 ...	5	1700 - 1920	140
	4.5	1610 - 1730	126
608 001	5	1700 - 1910	140
	4.5	1610 - 1730	126
608 002, 003, 005	5	1680 - 1880	225
	4.5	1500 - 1700	200
608 004, 006, 007	5	1700 - 1900	146
	4.5	1530 - 1730	130
611 ...	8	1330 - 1580	195
	7	1200 - 1400	170
613 001	9	3300	280





14. Leak test on oil- and water-protected starting motors

The necessary test equipment should be user-fabricated.

1. Test fitting as per drawing,
2. Caps over drive-end-bearing housing (no drawing, depends on starting motor)
3. Rubber seal ring, inside diameter = 80 mm, 3 mm thick.



Table of starting motors protected against oil and water

Part no.	Type	Type of protection ¹⁾
0 001 600 010	TB 24 V	■
012	TB 24 V	■
601 002	TB 24 V	■
601 011	TB 24 V	■
012	TB 24 V	■
015	TB 24 V	■
024	TB 24 V	○
025	TB 24 V	○ ○
608 002	TF 24 V	■
608 003	TF 24 V	■
004	TF 24 V	■
005	TF 24 V	■ 5) ◇
006	TF 24 V	■
611 001	TF 24 V	■ ○
002	TF 24 V	■ ○
613 001	TF 24 V	■ ○ 4)

- 1) ● Protection against heavy splash water
 ■ Protection when immersed
 ○ Protection against splash oil
 ◇ Protection against pressure oil

4) Test pressure under covering cap at drive end = 0.2 bar

5) Test pressure 0.55 bar



General instructions

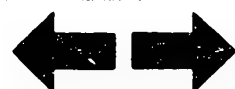
- = Protection against heavy splash water - Protection against splash water (with considerable force from any direction), corresponds to degree of protection IP-4A. During repair, the end cover (collector side), the housing and the solenoid switch mounted thereon must be carefully sealed with Kk 1 v 3 or Hylomar. A special test is either not necessary or shown, see table (para. 2).
- = Protection during immersion - Protection during immersion in water under stated conditions of pressure and time, corresponds to degree of protection IP-7.
During repair all bearing and housing joints must be carefully sealed with Kk 1 v 3 or Hylomar.
Test according to para. 5.
- ◇ = Protection against splash and pressure oil
There are no generally valid protection regulations for these starting motors, although usage necessitates a particular degree of sealing on the drive side.
Test according to para. 4.

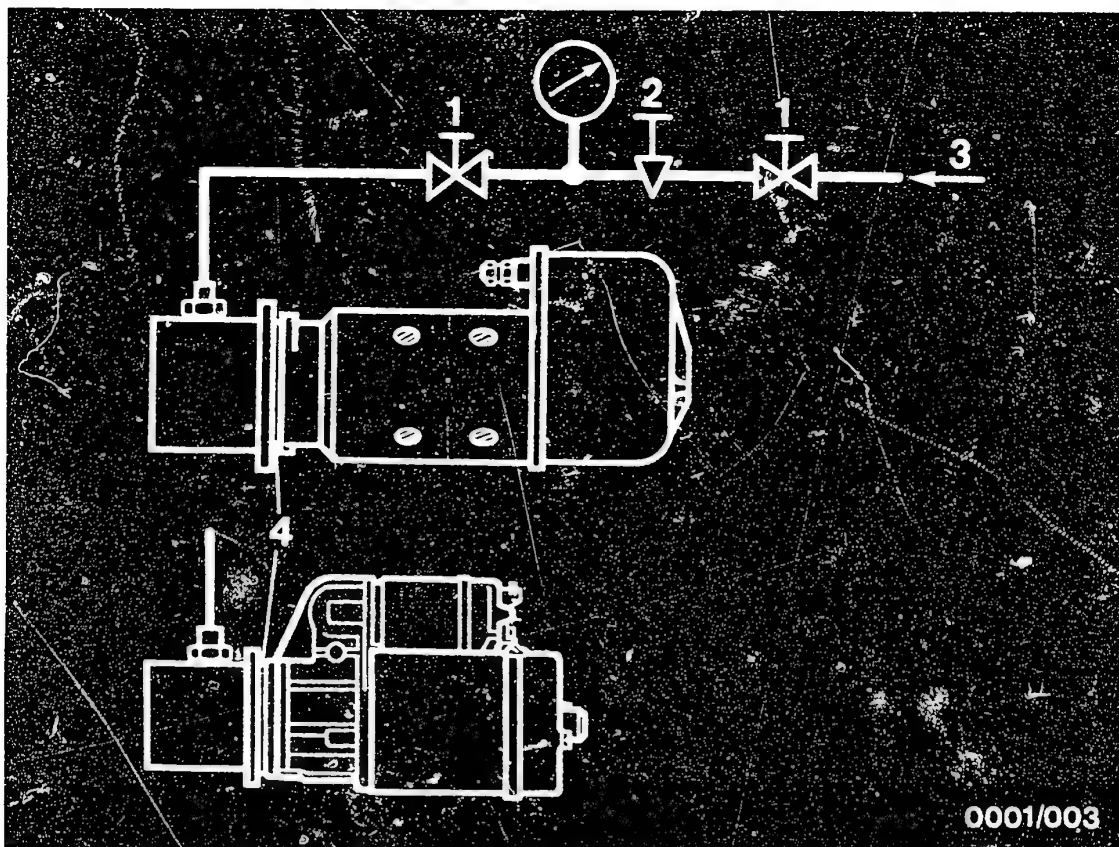
All starting motors are constructed according to the regulations for protection against splash and spray water. They have no special designation and require no special testing. In the case of every starting motor listed in the table (section 2), all the seals must be replaced whenever the starting motor is repaired, and when it is reassembled all the joints must be sealed with Kk 1 v 3. For information concerning particular places to which attention must be paid when sealing for a given starting motor, please consult the relevant service parts list.

F3

Leakage test

T-Type starting motors 0 001 6.., 24 V





0001/003

1 = Shut-off valve
3 = Compressed air

2 = Pressure regulator
4 = Seal the covering cap
with seal ring

Testing starting motors protected against splash and pressure oil ○◇ (Starter without intermediate transmission)

Mount the covering cap together with the seal ring on the drive side.

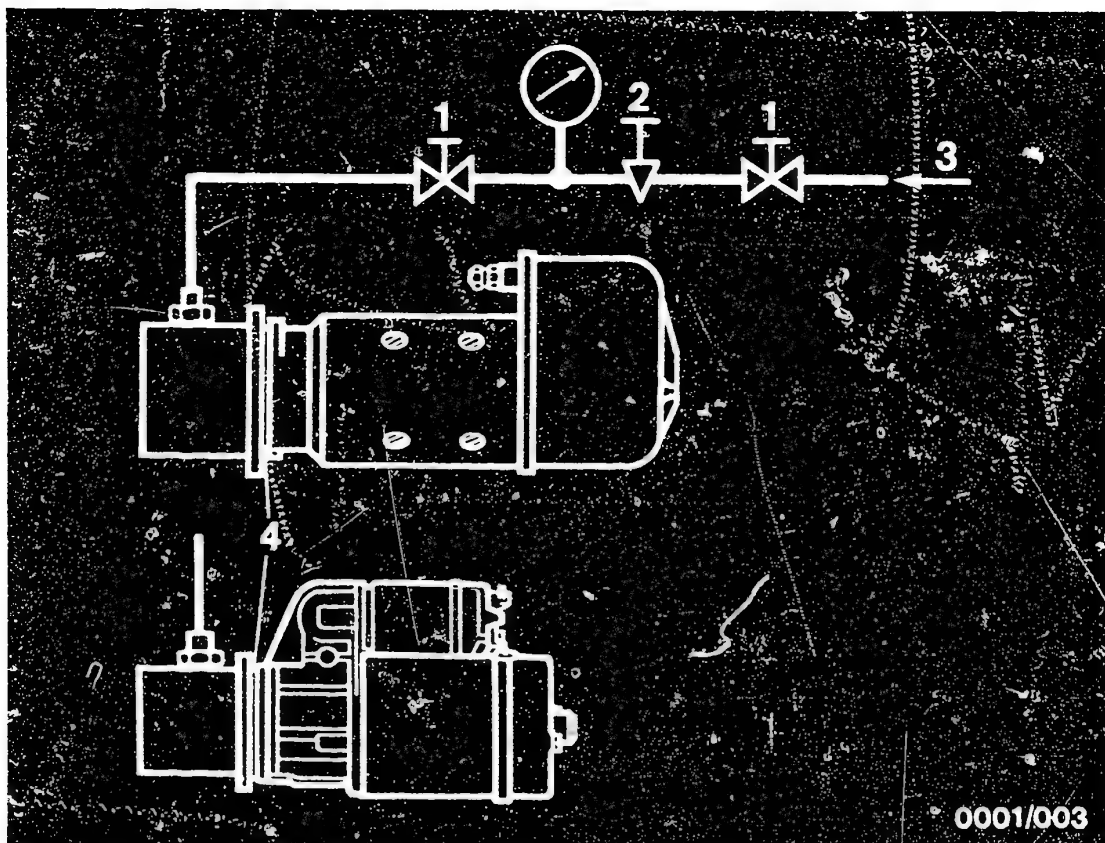
Feed compressed air (0.2 bar) into the covering cap. The covering cap must be completely air-tight. (See illustration).

F4

Leakage test

T-Type starting motors 0 001 6..., 24 V





0001/003

1 = Shut-off valve
3 = Compressed air

2 = Pressure regulator
4 = Seal the covering cap
with seal ring

Pressure drop test (Starter without intermediate transmission)

Increase compressed-air pressure to 0.5 bar. Close the shut-off valve and check the pressure drop.

In the case of covering caps with a volume of $< 1 \text{ dm}^3$, the pressure must not drop below 0.05 bar inside 5 secs for starting motors with protection against splash oil (10 secs for starting motors with protection against pressure oil).

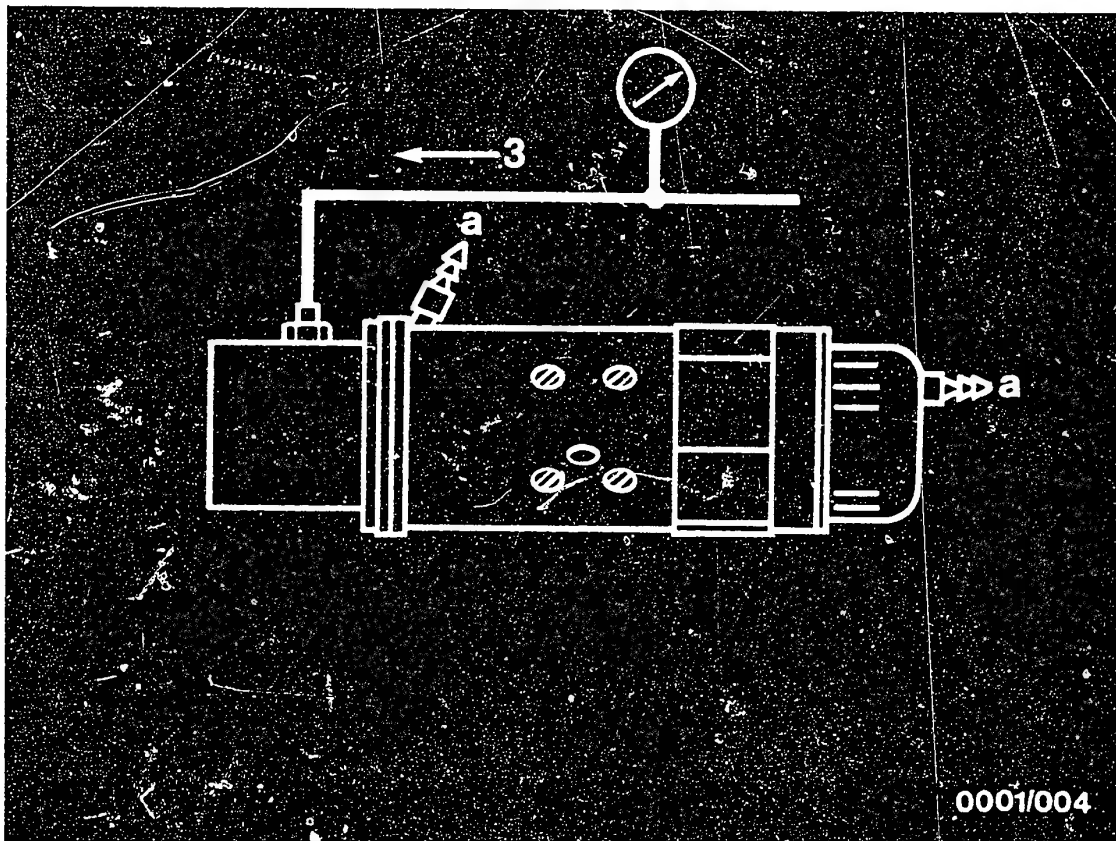
In the case of covering caps with a volume of $< 3 \text{ dm}^3$, the pressure must not drop below 0.05 bar inside 10 secs for starting motors with protection against splash oil (20 secs for starting motors with protection against pressure oil).

F5

Leakage test

T-Type starting motors 0 001 6.., 24 V





a = open

3 = Compressed air

Testing starting motors protected against splash and pressure oil ○◇ (Starter with intermediate transmission)

Mount the covering cap together with seal ring on the drive side.

The oil drain hole in the transmission housing and the tube in the covering cap remain open.

Feed in compressed air (0.5 bar), close the shut-off valve and check the pressure drop.

In the case of covering caps with a volume of $< 1 \text{ dm}^3$, the pressure must not drop below 0.05 bar inside 5 secs for starting motors with protection against splash oil (10 secs for starting motors with protection against pressure oil).

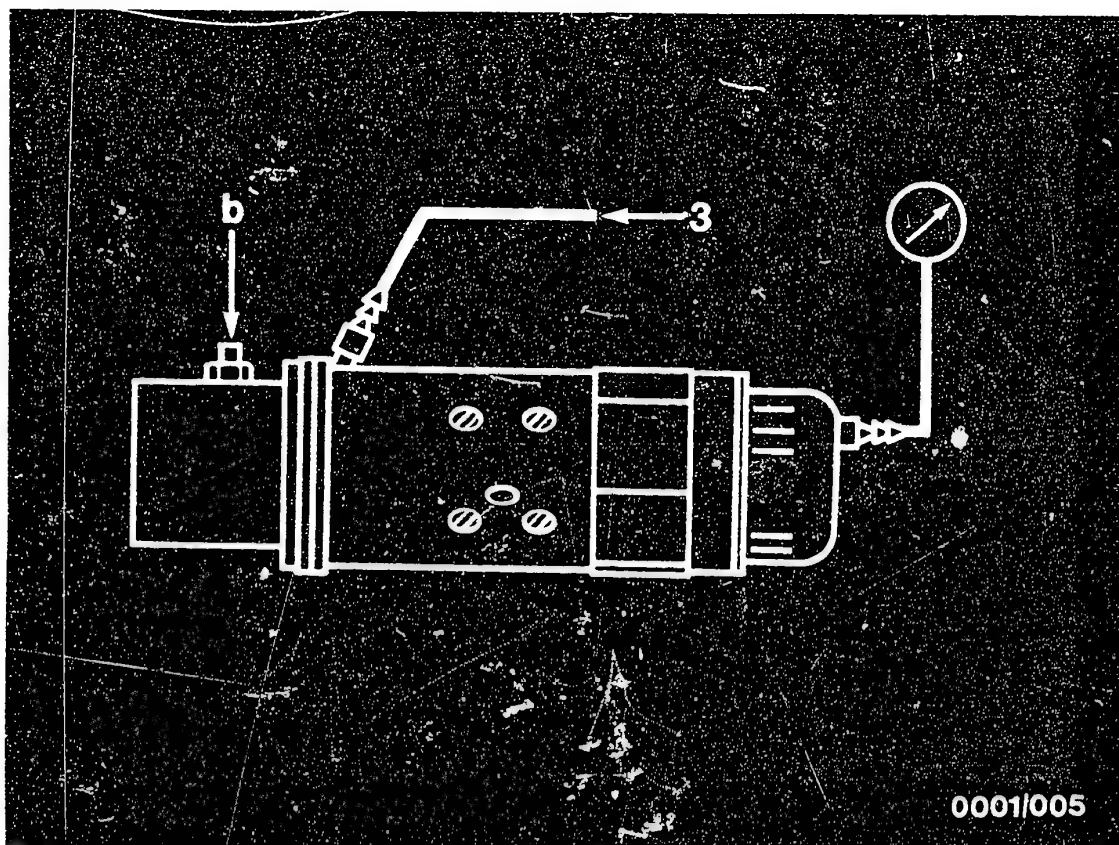
In the case of covering caps with a volume of $< 3 \text{ dm}^3$, the pressure must not drop below 0.05 bar inside 10 secs for starting motors with protection against splash oil (20 secs for starting motors with protection against pressure oil).

F6

Leakage test

T-Type starting motors 0 001 6..., 24 V





b = closed

3 = Compressed air

Close off the fitting in the covering cap and feed in compressed air (0.5 bar) via the oil drain hole (test connection) in the transmission and stator frame according to the above illustration, close the shut-off valve and check the pressure drop.

In the case of covering caps with a volume of $< 1 \text{ dm}^3$, the pressure must not drop below 0.05 bar inside 5 secs for starting motors with protection against splash oil (10 secs for starting motors with protection against pressure oil).

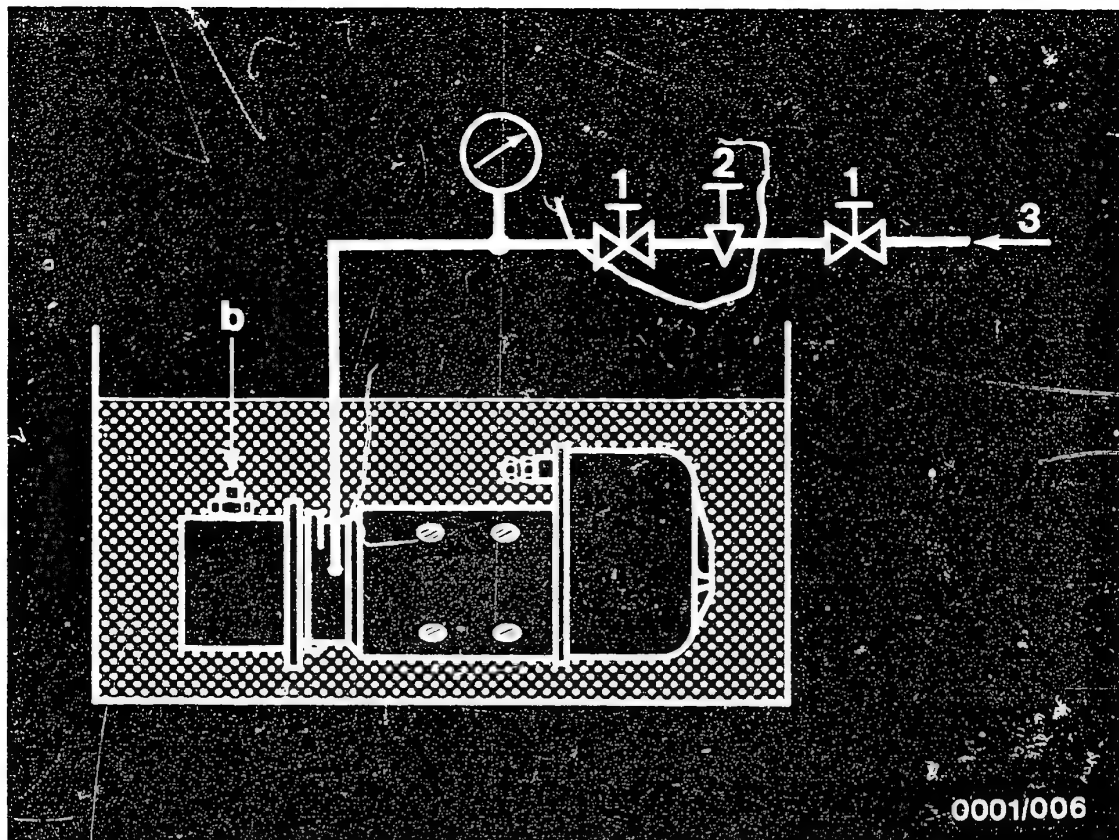
In the case of covering caps with a volume of $< 3 \text{ dm}^3$, the pressure must not drop below 0.05 bar inside 10 secs for starting motors with protection against splash oil (20 secs for starting motors with protection against pressure oil).

F7

Leakage test

T-Type starting motors 0 001 6.., 24 V





0001/006

- 1 = Shut-off valve
- 2 = Pressure regulator
- 3 = Compressed air
- 4 = Seal the covering cap with seal ring
- b = closed

In the case of a greater pressure drop open the shut-off valve and feed in compressed air up to 1.5 bar via the pressure regulator. Do not shut off the compressed air supply. Air bubbles given off when the motor is immersed in an oil or water bath serve to locate places which are not sealed. (See illustration).

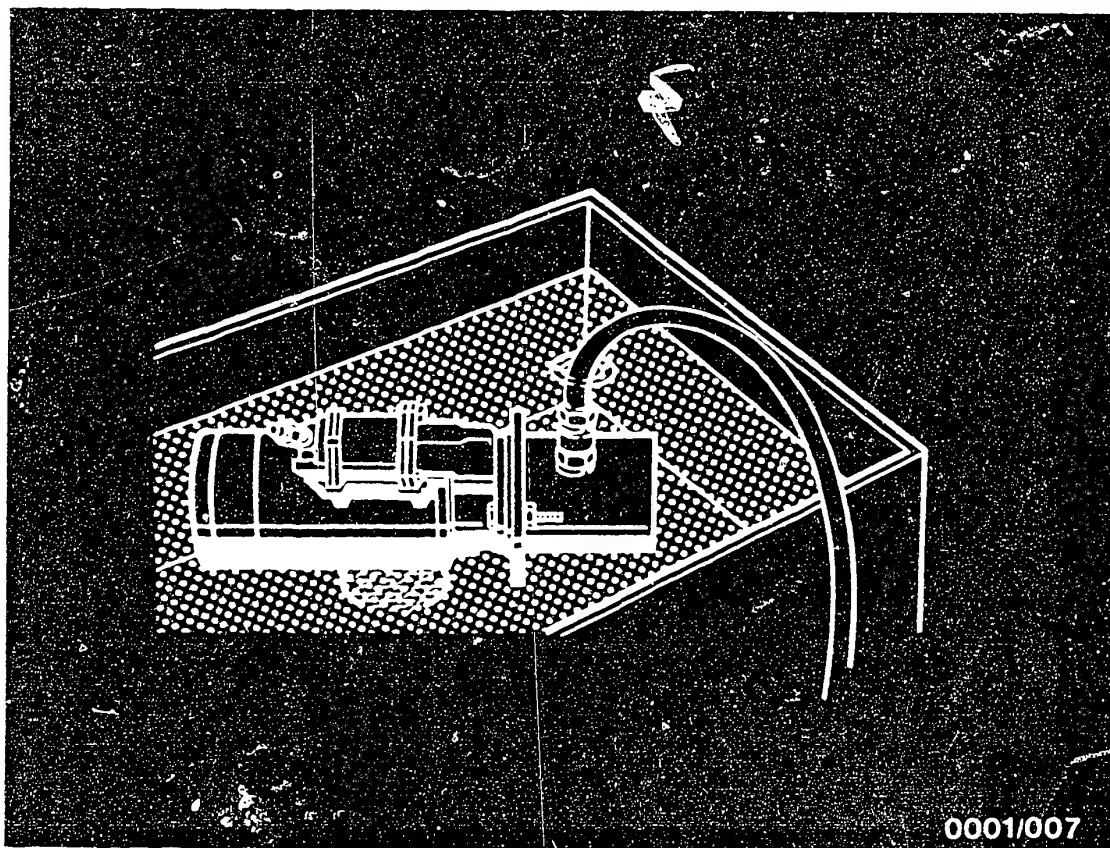
Reseal the starting motor and repeat the tests.

F8

Leakage test

T-Type starting motors 0 001 6.., 24 V





Testing immersible (watertight) starting motors ■

The test fitting is screwed into the oil hole in the drive-end shield (see illustration).

After the test, the openings for the test connection must be carefully resealed and closed.

Connect compressed air to the test connection. Test pressure: generally 0.2 bar, for special types pressure is specified. Completely immerse the starting motor in water.

Duration of test: 30 secs: for special types test duration is specified.

There must be no air bubbles.

F9

Leakage test

T-Type starting motors 0 001 6.., 24 V





After-sales Service

Technical Bulletin

Observe
the new workshop
filing system!

Only for use within the Bosch organization. Not to be communicated to any third party.

Change in starting motor marking
New performance designation for starting motors
(kW instead of HP)

00

VDT-I-001/111 B

Ed. 1 12.1975

Translation of German
edition of 3.11.1975

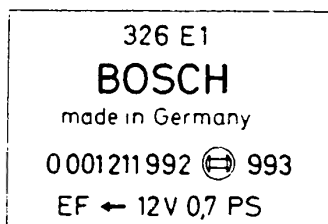
Conversion of performance data

According to West German law all performance data must be converted to the International System of Units (SI) by December 31st 1977. Consequently the HP (PS) value given on Bosch starting motors must be converted into kW. At the same time the previous definition of starting motor performance will be revised. Previous HP values were "nominal power"; the new kW values will represent "maximum power", with reference to the maximum permitted battery size. Thus a straightforward conversion of the old HP values into kW (1 HP = 0.735 kW) is not possible.

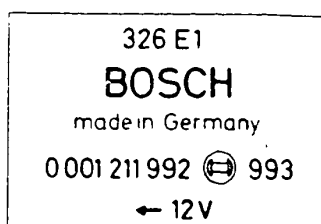
After-sales service notes

This conversion is of little relevance for after-sales service, since as from about September 1975 newly-developed Bosch starting motors have not been marked with a performance figure. The conversion for the already-existing starting motor program is intended to take place step-by-step up to the end of 1975. After this the marking will generally comprise only the part number and underneath it the direction-of-rotation arrow and the voltage. The type letters, e.g. EF, JD etc., and the HP value will have disappeared.

Present:



Future:



This also renders it unnecessary to give the kW performance in the test specification sheets VDT-WPE 510/... The first 7 figures of the part number are sufficient information for establishing the nominal values.

A cross-reference between the new and old type designations can be taken from the main Bosch catalog "Electrical Equipment for Engines" Sheet VDT-B 6/1 (Ed. 1). In case of inquiry, please contact your authorized representative.

Published by:
After-sales Service Training Center
Automotive Equipment (KH/VSK)

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L2

Technical Bulletins

T-type starting motor 0 001 6..., 24 V



After-sales Service

Technical Bulletin

Only for use within the Bosch organization. Not to be communicated to any third party.

New fastening screws for intermediate bearings in starting motors 0 001 600 .., 0 001 612 ..

00

VDT-I-001/119 B
7.1977

As of FD 722 (February 1977) only self-locking screws 1 003 450 009 are used in series production instead of the four tab washers 2 001 034 060 and screws 2 911 141 154 used to date. The screws can be recognized by their plastic-coated threaded section (color-painted).

New self-locking screws are to be used during all repair work; if new screws are not available, tab washers must be used with the old self-locking screws.

In the case of service part armatures use is made of cheese-head screws to secure the intermediate bearing to the drive housing for transportation purposes. These screws are to be scrapped. The self-locking hexagon screws (microencapsulated) and the tab washers are enclosed separately.

Tab washers 2 001 034 060 continue to be available individually. The tightening torque for the self-locking screws is 7 ... 8 N.m (0.7 ... 0.8 kgf.m).

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L3

Technical Bulletins

T-type starting motor 0 001 6.., 24 V



After-sales Service

Technical Bulletin

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NEW ENGAGEMENT RODS,
SECURING OF PINION ON INTERMEDIATE TRANSMISSION,
PINNING OF INTERMEDIATE BEARING,
on starting motors
0 001 600 ... to 0 001 613 ... (TB, TE, TF)

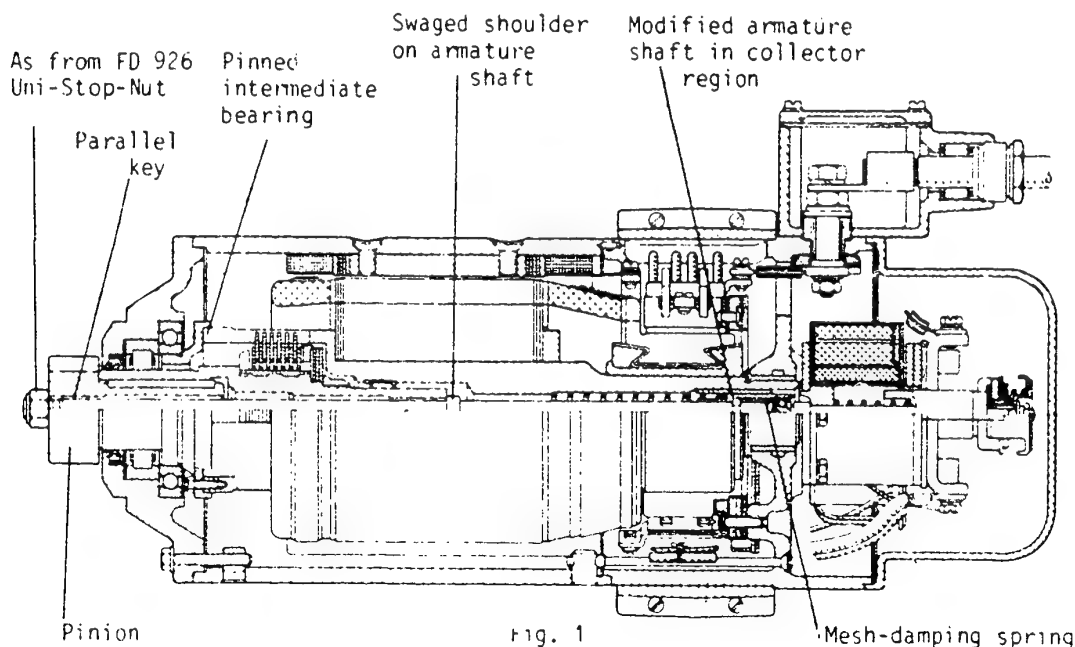
VDI-I-001/125 En
5.1980

Engagement rod (Fig. 1)

Up to date of manufacture FD 821 (Jan. 78) the engagement rods were delivered with a locking washer, a slot in the threaded section and a pinion-securing nut (Uni-Stop-Nut). When repairing engagement rods of this type, a new locking washer (1 000 146 001) and a Uni-Stop-Nut 2 003 315 002 (M 10x1.5) or 2 003 315 000 (M 10x17) depending upon the thread in question, are to be fitted.

As from FD 822 (Feb. 78) the following modification has been carried out: The slot in the threaded portion is omitted. In its place a 3 mm wide slot was introduced for a parallel key behind the threaded section. This serves as protection against the rod turning relative to the pinion. For this purpose, the pinion was provided with a corresponding slot in its bore.

The engagement rod is now always provided with an M 10x1.5 thread.



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Technical Bulletins

T-type starting motor 0 001 6..., 24 V



The pinion is only secured with the Uni-Stop-Nut 2 003 315 002 .

The mesh-damping spring has been moved from outside the guide sleeve to inside it.

In replacement cases, only the new-type engagement rod complete as a parts set with Uni-Stop-Nut 2 003 315 002 and parallel key 1 902 300 021 is delivered.

Cross-reference between old-type and new-type engagement-rod part sets.

Engagement-rod parts set old	Engagement-rod parts set new
2 003 050 001	1 007 010 010
003	011
006	013
019	postponed temporarily
021	015
023	016
1 003 050 008	012

IMPORTANT: When repairing an old starting motor using a new engagement rod (modification as from FD 822) it is necessary to fit a new pinion. On the other hand new pinions (with a slot in the bore) can be used as well for the old-type engagement rods (with locking washer).

A new Uni-Stop-Nut is always to be used when carrying out repairs and tightened with a torque of 35 ... 45 N·m (3.5 ... 4.5 kgf·m).

Cross-reference between pinions.

If an old-type pinion is ordered, a new-type pinion will be delivered automatically.

Old model	New model	Old model	New model
2 006 382 030	1 006 382 130	1 006 382 002	1 006 382 102
031	131	003	103
034	134	004	104
035	135	2 006 383 030	383 130
036	136	031	131
037	137	034	134
038	138	035	135
039	139	036	136
041	141	037	137
048	148	038	138
		039	139
		042	142
		043	143



2. Pinion fastening on starting motor 0 001 608 ...
and 0 001 609 with intermediate transmission

In these starting motors, the locking washer underneath the fastening screw of the outer pinion is no longer fitted. Instead, the new pinion-fastening screw 2 003 450 001 has been introduced. This has a self-locking "Loc-iel" strip (dark-colored strip on the thread). When carrying out repairs, only these screws are to be used. In cases of extreme urgency an exception may be made and the old screw-type with tab washer fitted. The locating hole for the locking washer is still located on the pinion face.

Fastening-screw tightening torque:

Old type	30...40 N·m (3...4 kgf·m)
New self-locking type	40...50 N·m (4...5 kgf·m)

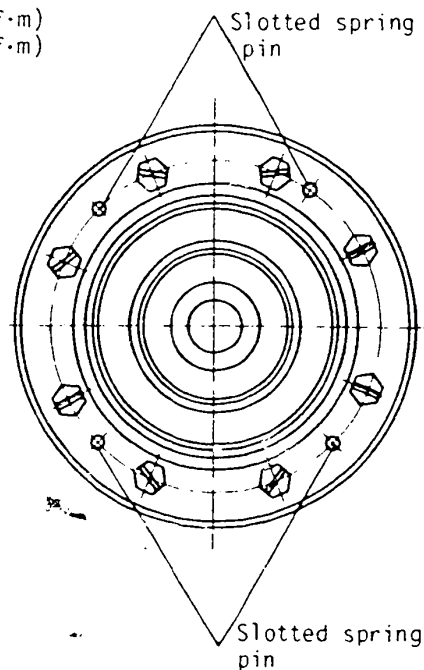
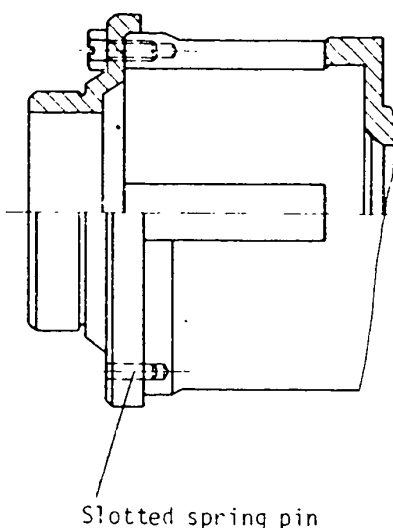


Fig. 2

3. Pinning of intermediate bearing (Fig. 2)

In several cases during starting motor repair it has come to light that the intermediate bearing fitted to the drive housing is no longer correctly fastened.

As a remedy - only for these special cases - the intermediate bearing is also pinned with 4 slotted spring pins. These pins are included in the Service-Parts list. They are included with the intermediate bearing on new armatures. The designation of the intermediate bearing is changed from 2 005 857 016 to 1 005 857 030.



After-sales Service

Technical Bulletin

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SCREWDRIVER BLADE FOR POLE-SHOE SCREWS
WITH RECESSED HEAD

00
VDT-I-001/1005 En
12.1979

From the beginning of 1980 pole shoe screws in starting motors will have recessed heads. A new pole-shoe screwdriver will therefore be necessary for the clamping support.

This pole-shoe screwdriver, with a recessed-head blade size 4, can be ordered from KH VKD 4 under the part number KDAW 9999/7.

First of all only the M 10 and M 8 pole-shoe screws will be delivered with recessed heads. These pole-shoe screws require the recessed-head blade size 4.

Recessed-head blades size 4 can be ordered from KH/ALP 2 under the part number 1 608 522 005. They are available in packs of 2).

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L7

Technical Bulletins

T-type starting motor 0 001 6.., 24 V



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Kenntnis genommen
Noted by:

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Project specialist

Inhaber
Owner

Meister
Supervisor

Mechaniker
Mechanic

0 001 600.. to 0 001 611.. - "T" - Starter
Change in Solenoid Switch 0 331 500..

VDT - BME 513/32 B

00
AL

Edition 4.1973
Translation of German
edition of 22.2.1973

To AV/S

Starting in October-November 1971 (FD 130/131) all solenoid switches 0 331 500.. were modified, without change of designation, so that they would be more vibration-resistant. In conjunction with this modification the shaft of the solenoid plunger was strengthened by an increase in size from 8 mm to 9 mm, and the suspension of the bridging contact member was changed.

During repair work, therefore, the following points should be noted:

1. Change of Listed Service Part Numbers Starting with FD 130/131

For the solenoid switch (single operation) 0 331 500 001, 004, 005, 006, 008, 012, 013, 014, 017, 019, 022, 024, 025, and 027 the service part numbers are changed as follows:

	from	to
Item 176: Solenoid plunger	2 330 369 001 2 330 369 005	2 333 528 001
Item 177: Helical spring	2 334 617 000 2 334 617 007	2 334 617 009
Item 178: Bridging contact member	2 331 321 031 2 331 321 033	2 331 321 035
Item 179: Lever (tripping lever)	2 331 901 011	2 331 329 006
Item 206: Set of parts for solenoid plunger	2 337 010 008	2 337 010 011

For the solenoid switch (parallel operation) 0 331 500 003, 015, 018, 021, and 023:

	from	to
Item 176: Solenoid plunger	2 330 369 003	2 333 524 008

No changes have been made to solenoid switches 0 331 500 011, 020, and 026.



KH/ALP 2 has only limited numbers of the following service parts of the older design in stock:

Bridging contact member	2 331 321 031 and 033
Tripping lever	2 331 901 011, and
Helical springs	2 334 617 000 2 334 617 007

2. Modification of the Solenoid Switch from the Old to the New Design

Basically, to modify an old solenoid switch from the old to the new design, all new service parts listed above (Items 176, 177, 178, 179, and 206) should be installed, and the 8-mm hole in the magnet core should be enlarged by drilling or reaming in accordance with Fig. 2. The countersinks on both sides of the core should then be machined in as shown by Fig. 2. Please check that the plunger shaft moves freely in the hole and does not bind.

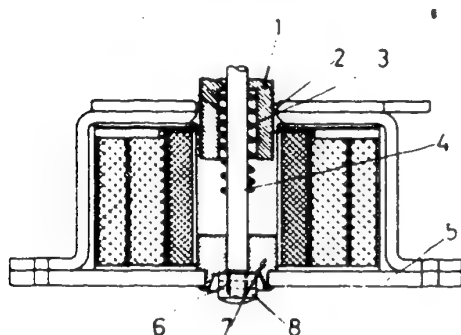


Fig. 1

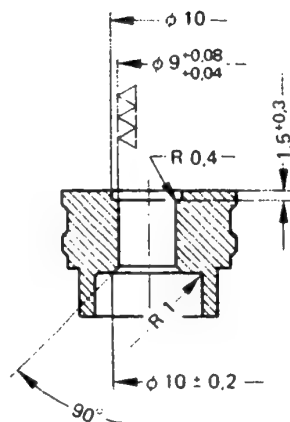


Fig. 2

- 1 Plunger
- 2 Bushing
- 3 Helical spring
- 4 Plunger shaft
- 5 Current coil with base plate
- 6 Cylindrical pin
- 7 Magnet core
- 8 Thrust cap

3. Assembly of Solenoid Switch

Please observe the information given in Repair Instructions VDT-WJE 513/2 AL, Issue of September 1966, Pages 11 and 12, as well as Service Parts List VDT-EVE 513/20 dated January 1971, Drawing TF (R) 24 V 15 PS - 0 001 608 002, ..004, and Drawing TF (R) 64 V 18 PS - 0 001 609 003.



In the following drawing we show a section through the solenoid switch (new design) from which you can obtain the position of the shims to adjust the contact gap and the gap of the tripping lever.

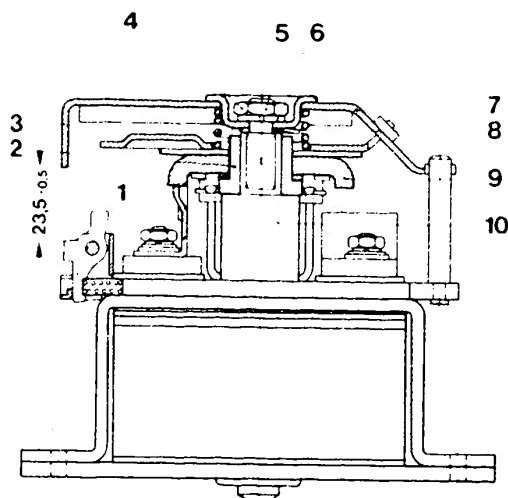


Fig. 3

- 1 Shim for bridging contact member
- 2 Guide bushing
- 3 Helical spring
- 4 Mounting nut, tighten with 1 - 1.4 mkp of torque
- 5 Mounting nut
- 6 Spring washer
- 7 Lever (tripping lever), Item 179
- 8 Shims for lever
- 9 Bridging contact member, Item 178
- 10 Solenoid plunger, Item 176

In no case should a magnet core which has a shaft diameter of 8 mm be installed in a current coil, with base plate (Item 175), which has been bored to 9 mm.

ROBERT BOSCH GMBH
Geschäftsbereich K 1
Abteilung VAK 6



After-sales Service

Technical Bulletin

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Parts Cleaning

Use of highly-inflammable cleaning agents, or cleaning agents which are dangerous to health

Gen.

VDT-I-Gen./18 En
7.1978

When cleaning parts which come from vehicle electrical products prior to repair, it is permitted to use the following cleaning agents: Benzine, trichloethylene (tri) and perchloroethylene (per). These are dangerous, and must be handled with appropriate care. The relevant safety regulations in West Germany are:

Regulations concerning work with inflammable liquids
(VbF) issued by the Federal Labor Ministry (BmA).

Safety regulations for the use of chlorinated hydrocarbons
as applied to the works ZH1/222
as applied to personnel ZH1/119

as issued by the Federation of the Trade co-operative Associations
(Central Association for Accident Prevention and Industrial Medicine)
Langartweg 103, D-5300 Bonn 5).

1. Benzine, acetone and ethanol (ethyl alcohol) are inflammable liquids and their mixtures with air are dangerous due to the risk of explosion. Parts washing may only take place in tanks or containers solely intended for this purpose and equipped with a "melt" safety device for the lid which, in case the liquid catches fire, causes the lid to close automatically and smother the fire. In the case of larger containers (exceeding 500 x 500mm) some form of suction extraction must be provided.
- 1.1 Generators, alternators, wiper motors, small-power motors and other electrical equipment for installation in vehicles are, in ever increasing numbers, being equipped with capacitors having long storage times (e.g. for interference-suppression purposes in radio-receiver or transmitter installations).

When washing such parts, it is possible that a capacitor discharge can occur when the part is immersed in the cleaning agent. This can lead to an inflammable liquid catching fire. For this reason, parts on which a capacitor is fitted are only to be washed in trichloethylene (tri) or perchloroethylene (per).

- 1.2 In the case of starting motors, it has already been pointed out in earlier repair instructions that the parts should be thoroughly dried after washing in benzine, this applies particularly to windings. With sliding-gear starting motors, the first test run after washing out must be performed without the closure cap in order to avoid the possibility of explosion.

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Technical Bulletins

T-type starting motor 0 001 6.., 24 V



2. Trichlorethylene (tri) and perchloroethylene (per) are both liquids whose vapors have a stupefying effect, and which are dangerous to health if inhaled over long periods. Tri vapor is heavier than air, and therefore especially dangerous at floor level. Gloves and goggles are to be worn when washing out parts in these liquids.

If cleaning of parts is carried out regularly, or continuously, in trichlorethylene only containers or tanks intended solely for this purpose are to be used, and the suction extraction device is to be switched on. When washing parts do not bend over the container.



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